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THE HAWAII TROPICAL CUT FLOWER INDUSTRY CONFERENCE

Growing into the 90's

Hilo Hawaiian
March 29th - March 31st, 1990

ITAHR · COLLEGE OF TROPICAL AGRICULTURE AND HUMAN RESOURCES · UNIVERSITY OF HAWAII

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Sponsored By

Cooperative Extension Service
College of Tropical Agriculture and Human Resources
University of Hawaii at Manoa

Governor's Agriculture Coordinating Committee

County of Hawaii

With Cooperation From

Big Island Dendrobium Growers Association
Dendrobium Orchid Growers Association of Hawaii
Hawaii Anthurium Industry Association
Hawaii Protea Growers Association
Hawaii Tropical Flowers and Foliage Association, Hawaii
Hawaii Tropical Flowers and Foliage Association, Oahu
West Hawaii Orchid Growers Association

PREFACE

On March 29-31, 1990, the Hawaii Tropical Cut Flower Industry Conference was held in Hilo, Hawaii. This conference was the first in recent memory to include all of the major tropical flowers produced and exported on a commercial basis in Hawaii: anthuriums, orchids, protea, and tropicals such as gingers and heliconias. Although each of these major floral groups has its own unique production problems, they face common marketing problems. Thus, marketing of Hawaii flowers was chosen as the unifying focus of the conference. The conference planners and participants believe that through improved and innovative marketing the industry will be able to realize the conference theme, "*Growing* into the 90's."

In addition to marketing issues such as transportation, handling, and market strategies and trends, production problems were also addressed. Concurrent sessions were held so that each floral group could concentrate on the production problems most relevant to them.

The conference was sponsored by the Cooperative Extension Service, University of Hawaii, the Governors Agriculture Coordinating Committee, and the County of Hawaii, with the cooperation of several floral commodity associations. Thanks are due to the hard-working conference committee members and all of the speakers who participated in this very successful conference program. Members of the planning committee were: Bernice Berdon, Greg Braun, Mike Crowell, Mike Goldstein, John Halloran, Gerry Hay, Lesley Hill, Karen Hunt, Darrell Kimura, Steven Lee, Ken Leonhardt (Chairman), Harry Lui, Corinne Moniz, Creighton Mow, Tom Nelson, Kent Pledger, Susan Robertson, Kelvin Sewake, Carol Siebenrock, Jerome Siebenrock, Tosh Sugita, Terry Toki, and Larry Yamamoto.

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WELCOME

Kenneth G. Rohrbach
Hawaii Institute of Tropical Agriculture and Human Resources
University of Hawaii at Manoa

On behalf of the Dean of the College of Tropical Agriculture and Human Resources, I welcome you to the Hawaii Cut Flower Industry Conference. I would like particularly to welcome our out-of-state and out-of-country guests. Conferences such as this don't just happen. They require a major effort in planning, time, and resources. The major effort in planning and time has come from your industry organizations and the College of Tropical Agriculture and Human Resources. The major resources are from the Governor's Agriculture Coordinating Committee and the County of Hawaii.

I am very pleased to see so many participants, a clear indication of the importance and timeliness of the conference. Your program for the next two to three days focuses on what is happening in the international cut flower industry and on the current knowledge of production, handling, and marketing of cut flowers. It is hoped that the panel discussions can stimulate some predictions of what will be needed for the industry to continue to grow in the 1990's.

I believe that your program also represents and focuses on another important issue that will be critical to the future success of your industry. That issue is the ability of several separate commodity groups to work together to reach a common goal and solve common problems.

Many of you are aware of the Governor's Agriculture Coordinating Committee's industry analysis program. You are also aware that previous industry analyses have been done on individual crop and animal industries as well as on some crop groupings, such as solanaceous, cucurbit, and leafy vegetable crops. When the Governor's Agriculture Coordinating Committee was formed in the late 1970's, the industry analyses were done on individual commodities that were of sufficient value and were represented by commodity organizations. The remaining commodities were grouped together for their industry analyses. The industry analysis program has done a good job of addressing production problems and focusing resources on solving those problems. We have not done as well at addressing problems that cut across several commodities, such as the problems relating to land, water, labor, capital, transportation, and marketing. I believe that these issues that affect many commodities can only be addressed if the commodity groups involved work together towards obtaining a solution. This conference is clearly a major step forward in this direction.

Again, I welcome you to the conference and to Hilo. For those of you from out-of-state, enjoy your stay in Hawaii. Don't be afraid to question the knowledge that will be presented here, as this is the way to progress. Thank you.

CHANGES IN GLOBAL FLORICULTURE CROPS: PRODUCTION CENTERS, CHANNELS OF DISTRIBUTION, AND PER CAPITA CONSUMPTION OF FLORICULTURAL PRODUCTS[1]

by
Harry K. Tayama
Department of Horticulture, The Ohio State University

Trends in floriculture crops production, on a global basis, have been enormously dynamic during the past four decades. West Germany's floriculture production area in 1950 was more than double that in Holland. In 1988, the greenhouse area in Holland was 70 percent greater than in West Germany. This turn-around is not surprising when one considers that West Germany's consumption of imported floriculture products increased by over 150 percent since 1970. Increases in flower production in Holland, Central America (Bogota), and Israel have been very significant since 1960. Today, however, there is a definite leveling off in those countries.

A significant percentage of carnations (75.2 percent), pompon chrysanthemums (73.5 percent), and roses (33.9 percent) consumed in the United States in 1988 are imported.

The dynamics of the trends during the past 40 years will intensify, as we will witness additional changes that will occur much more rapidly. This subject will be addressed in this presentation.

The population of the world continues to increase, even though several countries have instituted birth control programs. Medical advances have played a significant role in increasing world population. These medical advances will continue to impact world population, as fewer infants die at birth and more preventives and cures for diseases are discovered, resulting in lengthening longevity. Increases in population for regions and countries of the world will not be uniform. On a percentage basis, some countries will experience a decline in population increase, while other countries will have significant increases. Where people reside (urban or rural) within a country will also change with time.

Per capita consumption of floriculture products is increasing in the United States and other industrialized countries. This increase will continue in industrialized countries. As Eastern European countries become more exposed to floral products, their per capita consumptions are expected to increase. Pacific Rim countries are experiencing an enormous growth in technological advances, manufacturing, and exporting, as the world continues to shrink. The people of these countries should begin to purchase more floriculture products.

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[1]Professor Tayama's text was adapted from an outline he provided.

This presentation will include discussions regarding marketing studies/research, developing a channel of distribution, acquiring production technology, acquiring postproduction care and handling technology, and developing service skills.

Table 1. Current estimates of fresh cut flower production area for 45 nations of the world.

Nation	Hectares[a]		% of total	Cummulative %
Japan	13,976		23.4	23.4
Italy	7,600		12.7	36.1
Netherlands	5,081		8.5	44.6
United States	5,067		8.5	53.0
Mexico	4,250		7.1	60.2
Spain	2,900		4.8	65.0
West Germany	2,538		4.2	69.2
Colombia	2,122		3.5	72.8
France	1,692		2.8	75.6
Israel	1,483		2.5	78.1
Greece	1,430		2.4	80.5
Australia	1,111	x	1.9	82.4
Brazil	1,000		1.7	84.0
Costa Rica	800	x	1.3	85.4
Czechoslovakia	650		1.1	86.5
Poland	629		1.1	87.5
East Germany	591		1.0	88.5
Guatamala	500	x	0.8	89.3
Canada	493		0.8	90.2
Thailand	432	x	0.7	90.9
Honduras	400	x	0.7	01.5
Egypt	345	x	0.6	92.1
United Kingdom	344	x	0.6	92.7
Hong Kong	343		0.6	93.3
Portugal	308		0.5	93.8
Morocco	300		0.5	94.3
Soviet Union	300	x v	0.5	94.8
Yugoslavia	300	x	0.5	95.3
Jamaica	300		0.5	95.8
Switzerland	280		0.5	96.3
Denmark	251		0.4	96.7
Kenya	246		0.4	97.1
Belgium	215		0.4	97.5
Bulgaria	200	x v	0.3	97.8
Romania	200	x v	0.3	98.1
Hungary	200	x v	0.3	98.4
Peru	175		0.3	98.7
Singapore	150	x	0.3	99.0

Sweden	130	u	0.2	99.2
Indonesia	128	w x	0.2	99.4
Ivory Coast	100	x	0.2	99.6
Finland	74		0.1	99.7
Dominican Republic	60		0.1	99.8
Norway	52		0.1	99.9
Tunisia	30	x	0.05	99.9
Ireland	27		0.05	100.0
Total			100.0	100.0

a Source: Statistical Information on the International Production and Trade of Fresh Cut flowers, CLIF, The Hague, The Netherlands. 1985-1988 estimates. The latest available estimate is presented.
y Source: Isamura Hayashi, Kanagawa Horticultural Experment Station, Kanagawa, Japan.
x Source: Flowers Unlimited, International Developments in Floriculture. 1982. United Flower Auctions, Aalsmeer, The Netherlands.
w Orchids only
v Estimates include fresh cut flowers and potted plants.
u Under cover.

Table 2. Current fresh cut flower production area (hectares) throughout the world for selected species.

	Fresh cut flower production area (hectares)				
Country	Rose	Carnation	Chrysanthemum	Orchid	Gladiolus
Japan	344	456	4,864	65	307
Italy	812	1,950	1,028	*	1,211
Netherlands	829	287	625	177	*
United States	377	235	337	15**	2,590
Mexico	50	3.500	200	*	500
Spain	523	1.085	*	*	*
West Germany	420	117	530	32	86
Colombia	275	1,050	600	*	*
France	406	147	76	*	369
Israel	140	259	17	*	39

* Data not currently available.
** Hawaii orchids only

Where will the floriculture production centers be located after 1992? Spain and Italy are experiencing and will continue to experience significant increases in floriculture crops production as a result of the formation of the European Economic Community in 1992 and favorable climate for flower production, cost of labor much

less than in Northern European countries, satisfactory labor force (quantity and quality), low land cost, government cooperation, and an excellent channel of distribution; production and postproduction technology is questionable.

Mexico is experiencing and will continue to experience significant increases in floriculture crops production as a result of favorable climate for flower production, costs of labor much less than in the United States or Canada, satisfactory labor force (quantity and quality), and low land cost; government cooperation is questionable, channel of distribution is questionable, production and postproduction technology is questionable.

South Africa, Africa, Australia, and New Zealand have favorable climates for flower production (winter/summer), cost of labor is much less than in the northern hemisphere, satisfactory labor force questionable (Africa), low land cost, government cooperation questionable, channel of distribution questionable, production and postproduction technology questionable.

Table 3. Relationship of number of retail outlets to per capita floral consumption for selected countries.

Country	Population in millions (1985 estimates)	Number of retail outlets[a] (1987)	Retail outlets per million population	Per capita consumpion (1988 $U.S.)
Belgium/Luxemb.	9.9	5.500	556	24.50
Denmark	5.1	1,100	216	23.50
France	54.6	13,000	238	22.50
Great Britain	56.1	5,000	89	8.50
Italy	57.3	N/A	N/A	32.50
Japan	120.7	23,000	191	40.00
Spain	38.5	4,600	119	7.00
Sweden	8.4	1,800	214	28.00
Switzerland	6.4	2,000	313	36.50
Netherlands	14.5	11,000	759	35.00
USA	238.0	35,000	147	19.50
W. Germany	60.9	20,000	328	31.00

Sources: 1) H. de Boon, Westland Flower Auction, The Netherlands 2) The prospects of world urbanization, Populations studies No. 101, Department of International Economic and Social Affairs, United Nations, New York, 1987.

[a] Retail florist-type outlets only. Does not include mass market floral outlets.

Indonesia, Malaysia, Thailand, Singapore, Philippines: favorable climate for flower production questionable (species/varieties); cost of labor much less than in Japan, South Korea, and Hong Kong; satisfactory labor force questionable; low land cost,

except for Singapore; government cooperation questionable; channel of distribution questionable; production and postproduction technology questionable.

Per capita consumption of floral products has increased and continues to increase in many countries. There are many more countries that will demand flowers and become purchasers of floral products.

Marketing studies/research must be conducted. Selling versus marketing. Market research: Determine potential for sales of floriculture products. What crops are in demand (present and future)? What quantities are required? What sizes are desired? What time of year are specific crops desired? What colors are desired and at what time of the year? What age group is/will be purchasing flowers? What sex is purchasing flowers? What price range is desired?

Developing a channel of distribution to Europe and North America. Utilize auctions in Holland; they will be distributing floral products from Spain and Italy. Improving speed of delivery. Have electronic marketing in their plans.

Acquiring production technology. Education, education, education is of paramount importance. There is no substitute. It must be continuous. Study abroad. Intern abroad. United States, Holland, Denmark.

The government must provide cooperation: academics, teaching, research, extension. Investment capital. Tax incentives. Transportation (surface and air). Import restrictions.

Acquiring postproduction technology. Education, education, education. In the United States, it is estimated that over 10 percent of all harvested floriculture products is lost because of unsatisfactory care and handling techniques.

The future of the floriculture industry: There is no reason to believe that the enormous increase in per capita consumption of floriculture products experienced during the past four decades will not continue throughout the world. The most significant increase most likely will occur in areas of the world such as North America, Japan, China, Korea, eastern Europe countries, Australia, New Zealand, Republic of South Africa, and South Asia.

A very recent study conducted by the National Aeronautics and Space Administration (NASA) of the United States reports that a huge market for travel to Pacific Rim countries is expected to open by the year 2000. To prepare for this market, Boeing Company, Seattle, Washington, and McDonnell Douglas Corporation of St. Louis, Missouri, U.S.A., are developing a high speed airplane that will travel at Mach 3, three times the speed of sound (2,250 miles per hour) and seat 300 passengers. Travel time from Los Angeles to Tokyo will be four hours at Mach 3 instead of the present 10 hours in a Boeing 747.

An underlying factor regarding future production areas for horticulture crops is government cooperation.

Table 4. International trade of fresh cut flowers, 1987, valued in millions $U.S.

Region	Nation	Import value	%	Export value	%
European Community	Belgium/Luxbg.	45.7	2.2	1.9	0.1
	Denmark	37.4	1.8	1.9	0.1
	France	199.3	9.6	16.9	0.9
	West Germany	817.8	39.4	11.3	0.6
	Greece	0	0.0	3.8	0.2
	Ireland	8.3	0.4	0	0.0
	Italy	64.3	3.1	92.1	4.9
	Netherlands	110.0	5.3	1,323.1	70.4
	Spain	8.3	0.4	43.2	2.3
	United Kingdom	170.2	8.2	7.5	
	Sub-total	1,461.3	70.4	1,501.7	79.9
Rest of Europe	Australia	60.2	2.9	0	0.0
	Finland	10.4	0.5	0	0.0
	Norway	27.0	1.3	0	0.0
	Sweden	51.9	2.5	0	0.0
	Switzerland	112.1	5.4	0	0.0
	Sub-total	261.6	12.6	0	0
The Americas	Colombia	0	0.0	172.9	9.2
	Canada	37.4	1.8	13.2	0.7
	United States	242.9	11.7	5.6	0.3
	Sub-total	280.3	13.5	191.7	10.2
Africa & Israel	Canary Islands	0	0.0	20.7	1.1
	Kenya	0	0.0	26.3	1.4
	Israel	0	0.0	109.0	5.8
	Sub-total	0	0.0	156.0	8.3
Far East	Hong Kong	8.3	0.4	0	0.0
	Japan	58.1	2.8	0	0
	Singapore	6.2	0.3	5.6	0.3
	Taiwan	0	0	5.6	0.3
	Thailand	0	0.0	18.8	1.0
	Sub-total	72.6	3.5	30.0	1.6
Total		2,075.8	100.0	1,879.4	100.0

Source: Statistical Information on the International Production and Trade of Fresh Cut Flowers, CLIF, The Hague, The Netherlands.

WHOLESALING FLORAL PRODUCTS FROM HAWAII TO THE MIDWEST AND EAST COAST

by
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History of Wholesaling

Distribution channels change with changes in transportation and communication influenced by technological advances. Since the last century, man has made incredible advances in transportation, from the steam engine to the jet age, and in communications from the Pony Express to modern day facsimile machines.

Prior to the mid 1800's wholesaling was done at a very local level. There was no way to move products economically or communicate swiftly.

The wholesaler developed as modern transportation and communications became more effective. He was able to telegraph his orders the same day and ship via rail. The wholesaler purchased products on speculation, which enabled his customers to have better availability and timely delivery.

Wholesale traveling salespeople are no different from the modern day telemarketer. They went from door to door with their samples and catalogues and became the lifeline of the retailer. Salespeople were able to gather valuable information, such as regional economic conditions, new products offered by their competitors, notice changes in demand, i.e., consumer behavior, and update credit ratings.

The wholesale buyer, similar to the purchasing manager of today, played a very important part in the profit-making of the wholesalers. He knew the in's and out's, the right people, and where to get the best deals.

Traffic departments evolved to handle transportation. Credit and collection departments were needed for the finances.

The wholesaler today is not much different from 100 years ago. Technological changes seemed to have taken such amazing steps forward over from last century that it has shadowed what has really happened to the wholesaler.

As growers or shippers you have to determine the most economical way to market your product. You survey the market and find the customer that suits your marketing concept. Should it be a shipper, importer, wholesaler, retailer, mass merchandiser or directly to the consumer, choose one of these customer groups. Don't play the field and spread yourself too thin, as you will not be able to service all customer groups sufficiently. If you try shipping your products individually, you will probably become overwhelmed with the many distribution points

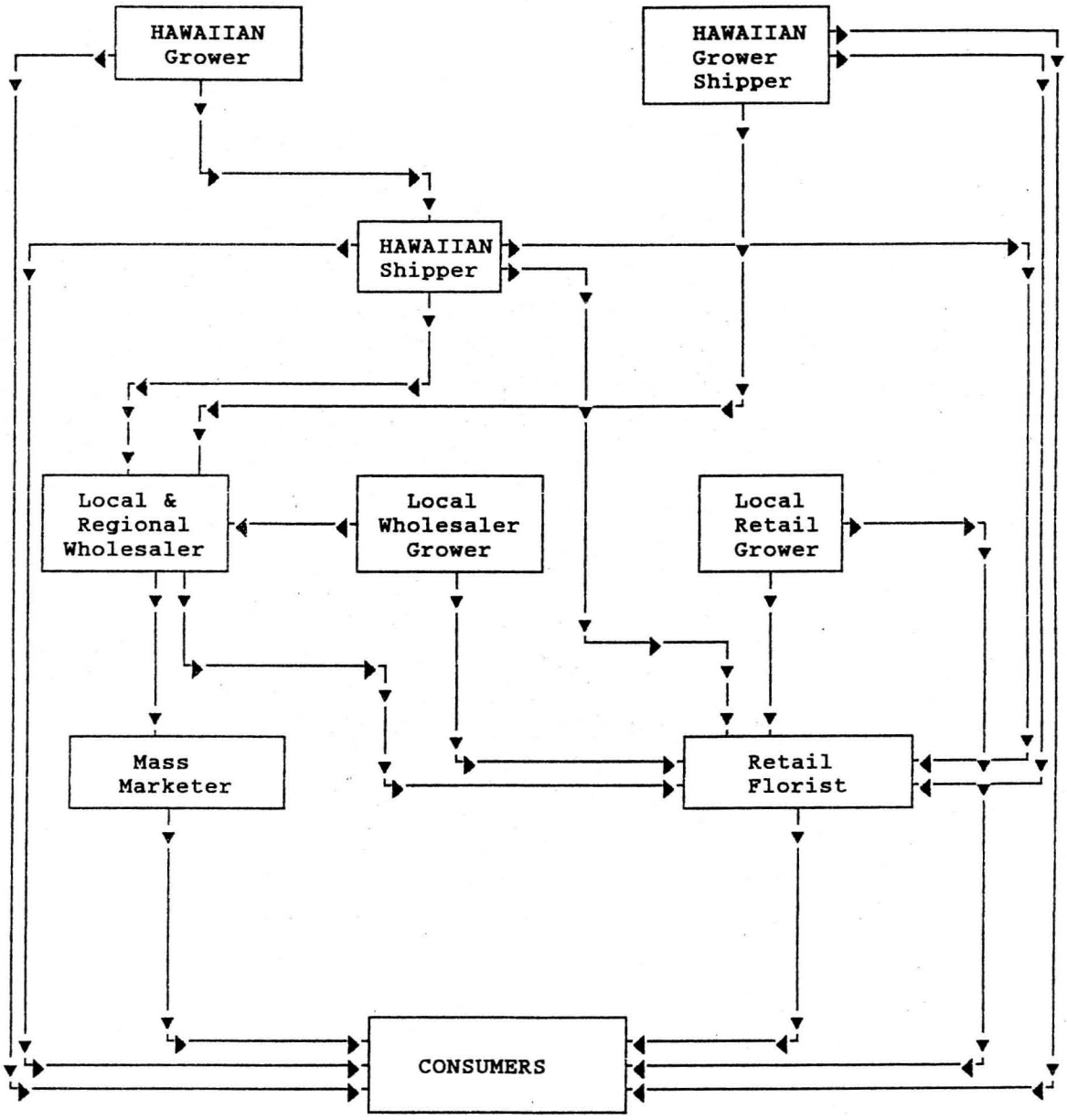

Figure 1. Hawaii floral distribution system - 1990.

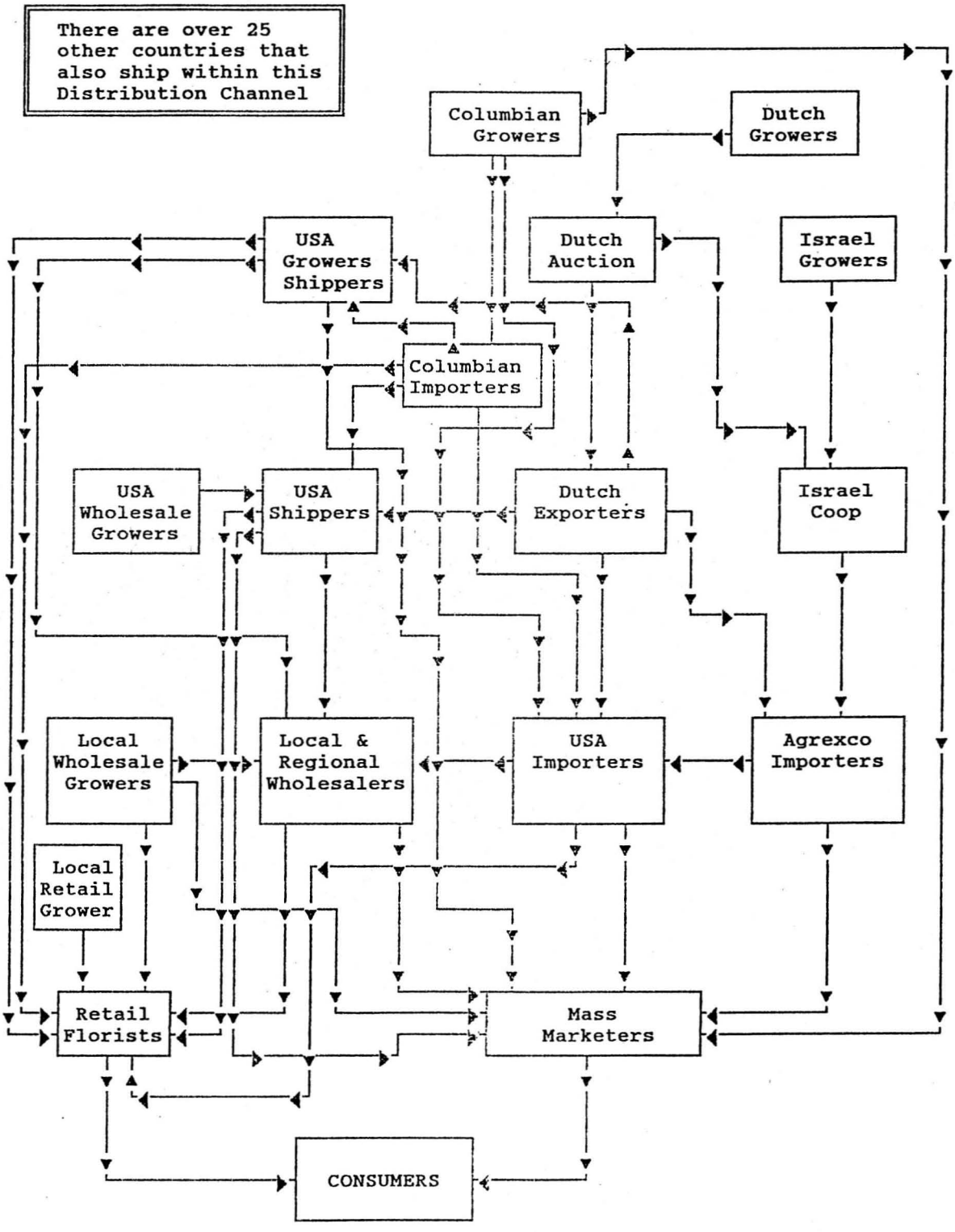

Figure 2. Wholesale florist in the floral distribution system - 1990.

that are available on the mainland today (see Figures 1 and 2). Do you want to create your own system or utilize the shipper or wholesale florist that already has the wheel in place?

As a grower and/or shipper, you put a package together describing your terms and availability with supporting brochures and posters. Ensure that you have a credit application and that you address your claim policy.

Make sure you are able to supply the wholesalers with the product when they need it. Quality plant material gives quality products which is the success of any good grower. This is also true for the success of a wholesaler. We need quality merchandise. Be different and stand out. This helps your customer to be different and more appealing to their customers. Communication is the success of any partnership whether in marriage or business. Consider your customer your partner. Timing a sales call to the wholesaler at a particular time during the day can mean the difference between a sale or a polite "no." Always ensure that you do your best. There are many times that by messing up a shipment or sending the wrong items, you can cause the wholesaler to go buy from your competitors. Pick the best time to ship your product. If the wholesaler needs to have the shipment to him by Monday morning, that would mean that you would have to pick, pack, and ship on a Sunday. You must be able to do so. Do not store the product over the weekend. Don't over-estimate your supply and capabilities. Be direct and up-front with your customer. Prices are a very important aspect for both companies to succeed and be profitable. If you agree to a price, stay with it, even though you may hear rumors of higher prices. A bird in hand is better than two in the bush. We are in a service industry and that is the key to your success.

Work with your wholesale florist, as he is geographically well located, he has the strongest distribution system, and he knows the retailer better than anyone else. You will find that in most populated areas you have a variety of wholesalers to choose from. Wholesalers know distribution, packaging , transportation, pricing, credibility and marketing. Wholesalers not only serve the small retailers but also the largest of supermarkets on a daily basis. Your local shipper can also provide many of these services.

Shippers and wholesale florists take all the risks as the product is purchased on speculation, many times without any orders from the retail customer. As a grower and/or shipper, one has to have a crystal ball to figure out how much we are going to sell tomorrow, the next day, the next week, or the next month. As wholesalers, we know the market trends, we know the holidays, we know our customers, but what is most unpredictable in this business is the weather. We have the same headaches as you do.

Wholesale florist very rarely buy 100 percent of a grower's production, mainly due to the flexibility that they need to be competitive, and they are able to obtain the product nearly anywhere in the world. There seems to be an abundance of product on a week-to-week basis. Even the holiday weeks: there seemed to be more bronze pom pons for the Thanksgiving of '89 than the market could bear, causing a very

depressed market. It seemed that every grower had the same idea at the same time. This makes it very difficult for wholesalers when the market is in such disarray.

Wholesale florists have, over the years, reached the point that once the product is delivered and signed for by the retailer, their responsibility ends at this point. By the end of the day there is no reason why a wholesale florist should accept claims from a retailer. This is not always cut-and-dry, especially in the sales of full boxes. I may do a special promotion for 20 boxes of mixed anthuriums packed by 24 stems in a tray...sell them all by the box...and by the following day or two find out that they are all turning blue because they got frozen in transit. The wholesaler has no recourse at that time with the airline and generally will ask for your support in helping out with the price.

The wholesaler considers the responsibility of the grower as ensuring that the product is cut and had postharvest treatment. The shippers responsibility is again to ensure that the product leaves their facility in a timely manner. A wholesaler's terms are generally very explicit. We order a specific quality and quantity to be shipped on a specific carrier for arrival on a specific date to meet our market day. Should a grower and/or shipper not perform, the relationship will deteriorate very rapidly. Should we be overshipped and not informed, the product will be handled on a consignment basis, but at the same time the grower and/or shipper would be warned not make this a habit. You should not ship more than what was ordered without first contacting your customer.

Wholesale florists have a variety of customers, all of whom have different demands. The wholesaler is flexible. The wholesaler sells to the mom-and-pop retailer in the rural areas, the fashionable florist downtown, the convenience stores with their weekly bouquets, the supermarket chain with over 200 locations in the metropolitan area.

Wholesale florists have retailers that may buy 100 stems of red ginger in a box at one time. Wholesale florists also have customers that buy 100 boxes of ginger by 12 stems, and the wholesale florist has a customer that only need two stems. Can you imagine the control and tactics that you have to decide on every minute of the day to ensure that all these customers are serviced equally in relationship to their volumes?

The typical wholesaler works with a 30-35 percent gross margin. When selling full box lots, wholesale florists work with a 20-25 percent gross margin. Wholesale florists have a higher mark-up on novelty products that have a tendency not to move as fast as the basic items. This would include many of the products grown in Hawaii. The main reason for this is because of the high loss factor due to speculation by the wholesaler.

The wholesale florist used to buy many products on consignment. I personally do not like consignment purchases because I feel that over a period of time it creates friction between the wholesaler and the grower/shipper. There are very few growers or wholesalers that work on consignment today. If you do wish to ship on

consignment be certain that you know what all the deductions are and that you do have it in writing.

The consumer today is an impulse buyer, so in order for the retail florist to provide immediate delivery he has to rely on same-day service, which is provided by his wholesale florist. The quickest service provided out of Hawaii to the Midwest and Eastcoast is 24 hours. Is it profitable for you as a grower or shipper to cut, pack, and deliver to the airport such a small order? Hawaii is one of the few places where the growers and/or shippers ship directly to retailers and even consumers.

The wholesale industry is a sophisticated distribution system. A wholesale florist salesperson has about four hours each morning to receive, unpack, process, call his 40 customers, and pull the orders to ensure timely delivery.

It is very difficult in the salesman's routine each morning to try and sell a retail florist a new variety of heliconia. The five or ten minutes the salesman spends on the phone trying to sell that 1 stem of heliconia at $5.00, he could have sold an $80.00 box of carnations...a very easy sale. This is one of our major problems in our sales system, trying to promote new or novelty products on any sales day. We try to spend off-peak sales time to develop and promote new items.

Wholesalers handle less than 5 percent of your product on an annual basis. Consider the potential of marketing your product. Some suggestions how other markets have promoted their product: through open houses or design schools or shows at the wholesalers level, wire services, floral organizations, i.e., AIFD, which is an organization of top floral designers in the USA, and advertise your product to wholesalers, retailers, or the public. You could either use trade journals, such as Flower News, Floral & Nursery Times, etc.

Provide educational material for the wholesaler. Customers like to buy from people who know what they're talking about. Industry-wide, it would be helpful if you would provide the wholesalers with this information.

Care and handling information would also be very helpful. You have beautiful product with great lasting qualities, and in the case of proteas, second use, i.e., dried. The consumer has to be made aware of this so that he realizes what he's paying for.

Irregular and uncertain availability is one of the biggest problems the wholesale industry has in dealing with Hawaii.

Transportation is key to the distribution of your product. Long transit times can ruin your product due to excessive delays. Transportation costs determine the feasibility of price for your product. Freight costs vary from 30 to 100 percent depending upon the item and method of shipping. As freight costs decrease, the more appealing your product becomes. The faster it gets to the market place, and ultimately to the consumer, the nicer the quality and the potential for greater demand. Can you, as an industry, with the support of local government agencies, obtain competitive freight rates to the mainland?

Increased Globalization of Cut Flowers

Wholesale florists are very aware of the continuing development of the global cut flower market. Importers have made it even easier for wholesalers in the most remote areas to be kept in touch with the rest of the world. They provide anthuriums from Mauritius, tropicals from Costa Rica, political awareness of the position in South Africa, so hopefully one day to provide protea from this region.

Changing Consumer Tastes to New and Exotic Flowers

Education and advertising will help change and develop the consumer taste not only for new and exotic flowers but for the floral industry as a whole.

Producers and Marketers of Tropical Flowers Face Challenging and Profitable Opportunities to Expand Trade Nationally and Internationally.

The 90's will be very difficult as competition continues to increase and make it even more difficult to maintain profits. Producers and marketers will have to watch every aspect of their costs to be successful in the coming years.

Identifying These Challenges and Opportunities for Hawaiian Producers of Tropical Flowers

You must first take care of your existing markets and customers. Only then should you pursue other opportunities. You had over 6.6 million visitors in 1989, could this not be an opportunity? Why not develop a relationship with an existing wholesaler in Chicago, which has a population of over 9 million? Why re-invent the wheel?

Global Outlook for Production

There will be many more flowers being produced from around the world that will be made available to the wholesalers, who are always looking for new sources and product.

Global Outlook for Trade

There are many political questions that will be answered in the near future, such as Japan as a trading partner, or special duty exemptions for the drug growing countries in South America.

Global Outlook for Consumption of Exotic Flowers

Wholesalers, with your support, will help develop the consumer to be more aware of exotic flowers. As an industry, we have great opportunities in achieving this goal together.

Leading Marketers Taking Advantage of Trends

The retailer is closest to the consumer. We, as wholesalers, and you, as growers, must be in tune with their markets and be able to react to their demands.

What Are The Emerging Products?

I recommend you use that crystal ball. And postharvest techniques? That I leave to the experts.

HAWAII DEPARTMENT OF AGRICULTURE MULTICOMMODITY MARKETING PROGRAMS: FUTURE DIRECTIONS

by
Masao Hanaoka
Administrator, Marketing Division, Hawaii Department of Agriculture

Good Morning. It is a pleasure for me to be here this morning to speak to you on how the State of Hawaii plans to assist the cut flower industry in promoting their products.

I am sure that some of you are not aware of the state's Agricultural Product Promotion Program, so let me begin my presentation by giving you some background information on this program. The state became involved in assisting agricultural commodity associations in their promotional efforts in 1963, when it funded part of the papaya industry's promotional program. Since 1963, the state has entered into 132 product promotion agreements, involving 16 different agricultural commodity groups, and has expended approximately $6 million in the process. Some of you old-timers know that the state's Agricultural Product Promotion Program originally operated out of the Department of Planning and Economic Development and was transferred to the Department of Agriculture on September 1, 1982. The Market Development Branch in our department's Marketing Division is responsible to carry out the promotional duties of this program. Who is eligible for product promotion assistance? Any association of producers of Hawaii agricultural products, which have good potential for export or potential for displacing imports to Hawaii, that is in need of disposing of temporary surpluses or that needs assistance in maintaining its market position in Hawaii may request product promotion assistance.

In instances where the applicant is a new or fragile agricultural commodity association or an industry with the potential for growth but unable to contribute its matching share, the department may waive its matching fund requirement for the first three years of any contract. However, a minimum 20 percent of matching funds is required for the fourth year of any such contract and a minimum of 40 percent for the fifth and all subsequent years of any such support.

Procedures for Requesting Product Promotion Assistance

An association applying for product promotion assistance funds must submit a written request to the Department of Agriculture. The request should contain:

1. A statement of the association's interest in and the reasons for requesting funding for a product promotion program.

2. A description of the membership of the association, and its share of the total statewide production of their product.

3. A statement regarding the potential market for their product and projections of crop production and price over the next three years.

4. A five-year marketing plan, including the ratio of the state funds to be matched with funds provided by the applying commodity group for each of the five years.

Consideration of Request

In considering the request, the department is guided by the following factors:

1. Will the state's investment in this promotional effort increase the value or the potential value of the applicant's industry?

2. The maturity of the industry making the request and its ability to maintain viability without government assistance in the promotion.

3. The number of producers and the associated industries which will be affected by the investment.

4. The availability of the product to satisfy market demand.

5. The degree of quality and the consistency of the product.

6. The availability of government funds to cover the cost of the program.

Following a favorable determination, the department will request the Governor's approval to enter into an agreement with the requesting association and if approved, the program is implemented.

Condition of the Industry

Our Hawaiian Agricultural Statistics Service reported that the wholesale value of Hawaii's flower and nursery products industry for 1988 increased 9 percent from the previous year to just under $60 million. Dendrobium orchid cut flower wholesale sales were valued at $2.6 million, an increase of 12 percent over 1987 sales. The value of sales of proteas was estimated at $1.2 million, up 26 percent over 1987 sales. Ginger and heliconia value of sales totaled $2.7 million, down 5 percent from 1987. This is a decrease, but one should look at this group's 265 percent increase of sales in 1987 over 1986 and 90 percent increase in 1986 over 1985 sales to notice that this industry is not doing too bad.

Anthurium producers, on the other hand, suffered through their second consecutive year of decreasing sales as production continued to be hard hit by bacterial blight. Wholesale sales in 1988 totaled $8 million, 7 percent lower than in 1987. A special anthurium blight survey conducted by the Hawaiian Agricultural Statistics Service covering the 12-month period ending September 30, 1988, revealed losses due to bacterial blight at an estimated $8.5 million. The survey measured plants lost, cost

of removing and replanting severely infected acreage, cost of field clean-up and additional sanitation procedures, and loss of actual and projected sales revenues as a direct result of the blight. Based on the number of marketable flowers lost as a direct result of blight, loss in sales revenue was pegged at $3.7 million. Except for anthuriums, the future of Hawaii's cut flower industry looks quite rosy.

What are we going to do now? Over the past seven years we have assisted the floriculture industry in its promotional efforts by developing poster, brochures, magazine-catalogs, a video, placing ads in the trade magazines and newspapers, attending trade shows, sponsoring professional flower arrangers at floral design shows, and listing of many of your businesses in our export directory. These types of activities have been the basis of our promotional assistance to the agricultural industry in Hawaii.

Future Direction

The questions I am supposed to answer today are what are: our plans for the future?; what is the state going to do to help promote floriculture products? After all, this is the fastest growing segment in our diversified agriculture industry, experiencing an average annual growth rate of 11 percent over the past five years. You can be sure that we would like to see your industry maintain this growth trend, but do you need the kind of assistance that we have to offer? Do you need generic promotions? Some of you have indicated that your money for promotional efforts would benefit you most if spent on promoting your company's product and not the generic product. Do you need to promote at all?

"Hawaii," I am told, is a name that has an exotic mystique that helps sell a product. Also, products from Hawaii are known for their quality, and quality sells. With these two things going for you, is there really a need for you to promote your products? We think there is, because we know that the market for your product is not limitless. We know that there are others outside of Hawaii that are looking at supplying your major market areas. Sometime in the future, you will find that the sellers'-market position that some of you may be enjoying now will fade away. Increased production by your industry without proper product promotion can bring about this situation, as was experienced by both the ginger root and guava growers in the early 1980's. Increased competition from foreign producers may also bring about this situation. The cut rose and carnation producers on the mainland were severely hurt when South American countries began exporting these products to the mainland. Holland has, over the past few years, heavily promoted their cut flower products on the mainland and most people will agree that they have been quite successful in their efforts to capture a larger share of the mainland cut flower market. I think your industry is already feeling the impact of tropical cut flower imports from Caribbean countries, Taiwan, Thailand, and Malaysia. Yes, we feel that there is need to promote your commodities. There is a need to keep your promotional efforts in line with your production projections. There is need for you to promote in certain market areas to maintain your market supply share, and there is need for you to look for new market areas. I also believe that it is to your benefit

that the state makes available funds to assist you in your market development and product promotion efforts.

The market for Hawaii's flowers is literally a world market. Every day, Hawaii-grown flowers are shipped to distant corners of the world. Of the nearly $60 million of floriculture products sold in 1988, at least 55 percent of this income was derived from out-of-state sales. During this period the anthurium industry shipped 64 percent of its production out of state, of which nearly 30 percent went to foreign destinations. But, market demand changed, and many times we have no knowledge or control of the elements that bring about these changes. We want to develop the capability to acquire this kind of information and get it back to you on a timely basis. By doing so, we feel that we can help you meet the changing market with new approaches and new products and whenever possible, enable you to take advantage of these changes.

Towards this end, a new economist position was authorized for our Market Development Branch in 1989. Although not filled to date, this person and the economist that we recently hired in our planning office will give us the capability to conduct market research studies to better define your market areas. As we plan to do with our other export agricultural products promotional efforts, we also want to fine-tune our efforts to promote floriculture products. After all, we only have a limited amount of dollars to help promote 16 different commodity groups and the Hawaii food manufacturers. Wherever possible, we want to get the most effective exposure of our agricultural products for the dollars we spend on promoting them. It certainly would help to have a bigger pot, but I am afraid that the only way we can increase this amount is to prove that our efforts are really paying off. During the past two and the current legislative sessions, we have found that the legislators are more frequently asking for a better way of evaluating the success of our efforts. Questions as to what we estimate to be a return on the state's investment have been asked during each of the last three sessions. Telling them that industry finds it difficult to separate sales that may have been a direct result of our promotional efforts from individual firm promotions sales has not been accepted favorably. In fact, this explanation probably gives them the impression that the commodity groups really doesn't care about receiving promotional assistance from the state. We always ask the commodity groups participating in our promotional activities for a project evaluation report.

In trade shows, participants are asked for the number of contacts made and of sale orders taken at the show. After the show we ask for sales that they felt resulted from the promotional effort; the dollar value of these sales; and as best as possible, an estimate of the amount of repeat sales that followed the original sale. Providing us with this type of data does require a lot of work on your part; the benefit, however, is that with this kind of documentation, we can better show what we are doing with our state funds and, at the same time, show how and what it is contributing to the state's economy.

Market Development Branch Budget

Market development and product promotion activities cost money. Let me explain how we obtain funds for our program. Our operating budget for marketing development and product promotion activities normally all come from the legislature, but in two different ways:

1. In the form of special appropriations earmarked for the promotion of specific commodities. We have $705,000 of this type of funds in our budget this year, to assist seven specified commodity groups. Examples of this type for appropriation are the $30,000 each earmarked for promoting anthuriums and dendrobium orchids. This type of appropriation must be matched by industry on a dollar-for-dollar basis. It seems that this matching requirement has become a problem in that some commodity groups have not been able to raise the required matching amount, and therefore cannot fully utilize the state's contribution. If not fully matched, the unmatched portion cannot be used by us to promote other agricultural products and at the end of the fiscal year will lapse back into the state's general fund.

2. In the department's administration requested budget for market development and generic promotion of diversified agricultural products. We have $350,000 in this year's budget to help promote diversified agriculture. These moneys are used to fund our trade show participations, our export directory, magazine-catalogs, processed food promotions, designer show participations, etc.

Last year we requested, through our congressional delegation, federal funds to promote Hawaii agricultural products in foreign markets. We were notified that the United States Department of Agriculture's Foreign Agricultural Service was appropriated $225,000 to promote Hawaii agricultural products during this fiscal year. With this fund, we expect to significantly expand our foreign market areas for our products. This prospect is exciting, because the world annual expenditure on flowers and floral products is an estimated $5 billion! Surely there is more room for us in this world market.

We have also requested a similar amount for use to promote our products during the next fiscal year, so you can expect that we will continue to expand development of our foreign market areas. Those of you who have your own promotional program know that promotion is not cheap. Knowing this, some of you have requested funds from the legislature for the purpose of promoting your products. We do not discourage commodity groups from lobbying for product promotions funds. However, we would like to see these groups develop a three- to five-year promotional program that they would be willing to present to us and the legislature to show that the industry is serious about promoting its product. Better yet, we would like to see commodity groups with similar products such as your cut flowers join together and start working as a unified group to develop and promote their products in their market areas. We would also like to see them develop a commodity groups assessment program that will enable them to raise funds to do this themselves, or if our assistance is requested, to meet our matching requirement.

Let me get back to how we are planning to help your industry in its promotional efforts. As I mentioned earlier, we have carried out the same type of promotional activities over the past seven years. These activities, we found, are the basic activities found in almost all product promotion programs, and we will be continuing along this line.

Trade Shows

We normally participate in six trade shows a year, three of which are basically nursery or cut flower oriented. We will continue to cover the cost of the booths, the overall design and construction of the exhibit, and the transportation of products to the show site. We will notify the respective commodity groups of our intent to participate and invite them to join us at the show, where we provide them with an area in the show that they can use to show their products and meet with the potential buyers, distributors, brokers, or other sellers. We feel much more comfortable when industry representatives are at the show with us, primarily because they can answer the product's varietal, production, availability, and price questions much better than we can. In fact, if industry expresses no interest in our participating in these shows, we will stop going to them. As I mentioned earlier, we go to at least six trade shows a year; the other three are food-related, but even at these shows, we have several arrangements of tropical flowers situated throughout the Hawaii exhibit area. Now that we have federal funds, we will be looking at participating in more of the international trade shows.

Printed Material

Participating in trade shows is a major activity for us. Roughly fifteen percent of our generic promotional budget goes into funding this activity. We feel that just showing our products for the duration of the show has merits, but that something that the exhibit visitor can take with him for future reference is more important. We have always asked the industry representatives to bring their price lists, fact page sheets, or "give-away" samples with them. We, in return, have always distributed our export directories, magazine-catalogs, posters, and brochures at these shows. Last year we did the floriculture video for you, which we just recently released, but other than that, not much else in the way of promotional material development. We intend to work with you in developing generic posters, brochures, mail inserts, and other product informational materials, so we can have at least one new printed product release per year.

Designer Shows

Getting the florists in your export market areas to know how to care for and use your flowers is very important. We have been to areas where people have seen your flowers for the first time. At shows as far apart as Tokyo, Japan, and Columbus, Ohio, we have had people look, touch, and smell anthuriums, heliconias, and proteas, not believing that they were real, and really couldn't visualize how to use them in arrangements. Staff and the industry representatives in our earlier promotional efforts put together all the flower arrangements, and let me tell you,

some of them looked like they were "put together" and not arranged. When we first hired a mainland floral designer to do our booth's flower arrangements, we were a bit shocked. We were so used to seeing local arrangements that we kind of expected to see what we had stereotyped to be a Hawaiian flower arrangement. Their arrangements were different but attractive, and now it is common practice for us to have a show-city florist not only do the flower arrangements but also design and construct the entire Hawaii exhibit. We feel that getting the florist acquainted with your flowers, how to handle and arrange them, is important enough so we have and will continue to sponsor designers to do this at different shows throughout the country.

Ameriflora '92

I am sure that some of you have heard of Ameriflora '92. This will be the first international floral exposition. We are looking at this exposition, with the intent of possibly having a Hawaii exhibit there. Availability of funds will determine whether we participate or not. It looks like an excellent opportunity to show your products in a grand manner along with what will probably be considered the best from the rest of the world. We look forward to a closer working relationship with you and welcome any ideas and suggestions from your industry on how we can improve our program. We are, after all, striving for the same objective and that is to enable you to sell all that you produce. Thank you.

WHAT IT TAKES TO BE SUCCESSFUL: PROMOTION, AN ESSENTIAL FACTOR IN MARKETING

by
Jan van Doesburg
Chairman of the Flower Council of Holland

It is with great pleasure that I have accepted your invitation to speak at this "Hawaii tropical cut flower industry conference: Growing into the 90's."

As you all know, Holland plays a leading role in the world's flower business. All over the world Holland is known as the land of flowers and plants. Indeed, the Netherlands is the world's greatest exporter of flowers and plants. Holland's share of cut flower and pot plant exports worldwide amounts to 70 percent and 50 percent, respectively. Three quarters of the 8.6 billion cut flowers and 730 million pot plants which are grown in the Netherlands each year are destined for export. Last year these export activities brought in 2.4 billion dollars.

As a representative of both the Flower Council of Holland and the Association of Dutch Flower Auctions, I will gladly present to you the reasons to which we owe this favorable position. More specifically, I will speak about the marketing instruments we use in order to achieve, to hold, and to further develop our position.

Speaking about marketing, I will present first our product, then our distribution and price setting system we have developed, and third the promotion, as an essential part of marketing. Finally I will look more closely to our activities in the American market.

Range of Products

One of the factors for the successful export of flowers and plants from the Netherlands is the breadth of the range available for purchase.

The Netherlands has a total of 11,000 flower and plant nurseries. The majority of these (8,000) are engaged in production in greenhouses. The remainder grow flowers in the open air. The total surface area of glass in the Dutch flower sector amounts to almost 12,500 acres. Added to this are around 5,000 acres of open land. The flower and plant sector is of great importance for the Dutch economy. Out of a total of 14,000,000 inhabitants, 23,000 people are employed in the production in this sector. Another 45,000 persons are employed in the marketing of our flowers and plants: auctions, wholesalers, and retailers. This gives us an overall total of 68,000 people working in the ornamental sector.

Nowhere else is such a wide selection of flowers and plants available as in Holland: more than 5,500 different cut flowers, 2,000 different pot plants, and 2,200 garden plant varieties are available almost all year round. With sales amounting to some 320 million dollars at the Dutch Flower Auctions in 1989, the rose occupies the first

place in the Dutch cut flower range and no less than 14 percent of total sales from flower auctions comes from roses. Chrysanthemums currently hold the second position, followed by carnations, tulips, lilies, freesia, gerbera, gypsophila cymbidium, and alstroemeria. We have a very broad assortment not only in many different crops, but in every crop there are a lot of varieties.

Quality

Another element in the international popularity of Dutch flowers and plants is their good quality and long life. All products intended for export are inspected by experts in the flower auctions and the Dutch Plant Protection Service. Dutch growers and dealers do all they can to guarantee long-lasting products of high quality. In addition to examination by individual growers, a lot of institutes and research stations are involved in horticultural research of products. The three most important research stations for the flower and plant sector are in Aalsmeer, Lisse, and Naaldwijk. The research work carried out at these research stations is financed 50 percent by the Government and 50 percent by all growers and dealers.

Holland can be proud, I think, of it's wide range of high quality products. However, producing excellent products alone is not enough to assure good results in sales. Since we are dealing with perishable goods, the way the products are handled and cared for as soon as they leave the nurseries is very important for their success. This brings me to the second reason for our prominent position as the Flower Country: the well developed distribution system we have been able to set up.

The Auctioning System

The most important link between grower and dealer is the network of nine flower auctions held in The Netherlands. The Dutch auction system is unique. These auctions are cooperatives of growers and since the establishment of the first flower auction in 1912, the heart of the price-setting system is the auction clock. Some 90 percent of all flowers and plants grown in Holland reach their point of sale via the auction clock where the price is determined by supply and demand. Buyers stop the auction clock by pressing the button. It is an open price setting system. If a buyer presses too soon, he must pay a higher price. If he presses too late, he has no flowers. The advantages for both the grower as the exporter/buyer are clear.

Advantages of the Auction System for Producers

- specialization
- market price
- immediate payment
- no selling problems
- access to International markets
- low selling costs

Advantages of the Auction System for Exporters

- low buying costs
- access to total assortment
- equal chances for each buyer
- knowledge of market price (open price-setting system)

This system enables all the market-parties to sell or buy their goods for the price that reflects the real supply and demand conditions. In this way, producers don't compete with each other on price but more so on quality and quantity. Buyers at the auction all have the same possibilities to buy the total assortment of products.

Total sales at Dutch flower auctions last year amounted to over 2.1 billion dollars, 150 million more than in 1988.

The structure of the Dutch distribution system is in fact very simple:

Distribution System: Growers, Auctions, Exporters, Importers, and Retailers.

Starting with the grower, I want to stress first of all that the grower does much more than just producing. Growers play an important role in improving quality, availability, introducing novelties, and decreasing costs, all factors with a positive impact on the commercial position of those who sell. Not to mention the fact that they supply uniform products in standardized units, easy to handle down in the distribution chain.

At the very moment of harvesting the distribution starts. The grower cuts the stems, prepares bundles, stores them cool for the time being. Then transport to the auction takes place, where, after inspection, they are sold within a few hours, exporters carry them all over the world and importers see that the retailers get their fresh stocks in time. The system gives a guarantee to deliver the desired products in time at the right place.

The distribution chain with, in its center, the vital role of the auction, serves five functions:

1. Gathering information
2. Price setting
3. Distributing products
4. Distributing information
5. Collecting money

Before production is started long term market information is gathered and orders have to be collected.

After production and transport to the auction, the first and most important price setting takes place. As I explained earlier, this takes place in front of the auction clocks.

The third function of the distribution system, the distribution of the products itself, is the most visible one. Daily, the millions of flowers go in a steady stream through the auctions' halls. Once they are sold, air-conditioned trucks take the flowers to their diverse destinations in Europe. Aeroplanes also play a significant role in the transportation, especially in the intercontinental transport.

Distributing information is not always visible, but it is an essential part of the system. Without information about products and how to handle, preserve, and present them, retailers would have to settle for lower consumer prices.

The last function of the system to be mentioned is collecting money. The auctions do this for the grower and they do it efficiently. The same day you have bought the flowers at the auction the money is written off from your bank account.

To conclude this section on our distribution system -- the second reason for our success as flower exporting country -- I'll summarize briefly the role of the auction, the very heart of the system. The Aalsmeer Auction has more than 150 acres of floor space. The auction's role consists of collecting, conditioned storing, inspecting, selling, printing commercial documents, invoices, collecting money for the growers, leading the stream of products to the buyers to whom they provide acres of working space. And of course the auctions also do their best to attract from all over the world new buyers and new suppliers to complete our own production. We have flowers from the Mediterranean, Africa, Brazil, Asia, and South and Middle America. They are doing everything to create a real international market, bringing together parties who can be sure to find business partners from all over the world.

Promotion

A further reason for the success of the Dutch floristry sector can be explained by the cooperation in the field of promotional activities. This brings me to the subject of the Flower Council of Holland. The Flower Council of Holland was founded in 1980 on behalf of the whole Dutch Flower Industry. It was set up to stimulate the sales of our cut flowers, potted plants, and bedding plants by means of all kinds of promotional activities, both in Holland and abroad.

How is the Flower Council organized? The Flower Council is a Foundation. The Board consists of representatives appointed by various bodies in the field of production and trade: growers, wholesalers, exporters, and retailers. The Board makes all policy decisions concerning promotional activities to be undertaken. As far as marketing matters are concerned, the Board can rely upon the advice and recommendations of the Flower Marketing Organization Holland.

The Flower Marketing Organization Holland is responsible for surveying the home and foreign markets and carries out market research programs. On the basis of the market research, the Flower Marketing Organization defines its marketing plans. The Flower Council of Holland translates these plans into specific promotion programs. The market research must give us an understanding the bottlenecks and

of opportunities in the various markets. This will permit us to promote the right activities. After these activities have been carried out, we usually test their effects.

As an example of the market research carried out, I can mention studies of the worldwide flower production and distribution system. What are the production centers, and which countries play a leading role in the flower export, and what is the strength of the Dutch position in the different markets? These studies are mid- and long-term market prognoses of consumption of flowers in the different countries. Here I'll permit myself a little side-step in order to give you a general view of the different consumption levels in the world.

Consumption of Flowers Per Capita in 1989 in $

Japan	41
Holland	36
Germany	31
France	22
USA	18

As you can see, the difference in the amount of money spent on flowers is big. The difference becomes even more striking if we consider the amount of stems bought by the consumers in the various countries. In countries with a high consumption of stems the average price level is lower.

Consumption of Flowers in Stems Per Capita in 1986/87

Holland	145
Germany	66
Japan	40
France	26
USA	14

Just look at the difference between the consumption in the USA and the Netherlands! This indicates great potential for the American market. These are interesting results of market research, indeed, but let me come back to the subject of the Flower Council.

The way in which the Flower Council's activities are financed is unique in the international flower industry. On the basis of a system of levies, all Dutch producers, wholesalers, exporters and retailers are paying their share of the costs. These levies take up, all in all, 0.8 percent of the total turnover of flowers and plants at the auctions. The total of levies finances research, marketing research, and promotion.

The principal methods used by the Flower Council of Holland to pursue its promotional activities are advertising, public informations, public relations, and trade support. For our activities abroad we have the support of six foreign "P-R" agencies in West Germany, France, England, Italy, Japan, and the United States (New York).

Let me give some examples of our activities. Our activities can, in general, be divided into two groups, promotion aimed at the consumer and promotion aimed at the trade itself. The trade-orientated activities take up the lion's share. In the Netherlands itself, in Germany, and in the United Kingdom, we approach the consumer directly to promote the sale of flowers by means of advertising campaigns on the radio and on television, on billboards, and by means of advertisements in the consumer press. In Germany and in the United Kingdom we work together with national organizations. The advertising campaigns are general and of a neutral nature, by which I mean that the origin of the flowers is not mentioned. The sole aim of this advertising is to increase the purchase of flowers in general. After all, customers entering the shop can not see where the flowers come from. They simply buy what they find attractive. Such a consumer approach only makes sense for us if our market share in the market in question is at such a level that we can benefit automatically from a rise in consumption.

As I said above, the majority of our activities are aimed at the trade. We issue our own quarterly, "Holland Flower," which is distributed throughout the world to wholesalers and retailers alike in an edition of 110,000 copies in six languages to inform the reader of the Dutch range. The languages are English, French, German, Italian, Japanese, and Dutch.

Our foreign agencies inform the professional press by means of regular press releases. They also distribute material such as catalogues, posters, stickers, and video tapes giving flower care tips and the like to the trade.

Apart from this written information material, we also approach the trade directly by organizing seminars, information days, design shows, and courses for both retailers and wholesalers.

Courses are organized for florists where attention is paid not only to product knowledge but also to marketing techniques such as shop lay-out and presentation and how to approach your customers.

Such a program is currently being run in the Netherlands and the United Kingdom. Throughout 1990, the Flower Council of Holland will be running a series of 40 so-called road shows in various locations in the United Kingdom. The road shows are informal sessions covering all aspects of the floristry trade and are aimed at both shop owners and staff. They are designed to help florists increase sales by providing new ideas and suggestions on items such as impulse sales as well as giving useful advise on staff and management. The road shows are split into two sections. A theoretical part and a demonstration given by one of Holland's top flower designers.

Product information and marketing information are given. We have also set up a demonstration shop.

An example of an information program we developed for a specific section of the trade is our so-called Supermarket-Kit, with instructions and information for supermarkets, with written material and videos. Although the specialized retailers represent an important class of outlets, in some countries like Holland itself, Germany, England, and Switzerland, the supermarket chains are rapidly increasing their share in sales of flowers and plants. Their strong point is their number of outlets, the presence of thousands of potential customers, and their experience with physical distribution. The weak point seems to be product knowledge and commercial attention. If you treat flowers like a shelf of sugar, don't blame the product for not being successful. So, we decided to provide an information kit, consisting of a video and care and handling information sheets, specially written for non-specialized supermarket personnel.

To support our wholesalers and exporters, the Flower Council of Holland is present at a great number of foreign trade fairs. To mention some of them: IFTEX in London, Iberflora in Spain, Hortiflor in France, Miflor in Milan, IPM international plant fair in Germany, and in more places. We invite our exporters to join our Holland Booth and support them by giving them all logistic, practical, and organizational assistance. Furthermore, we support them by informing the trade press of their presence and by inviting journalists on the stand.

Finally, we organize seminars in Holland for our exporters to inform them of the market and distribution developments in the various foreign markets, and about the potentials, the problems, and our activities.

After having talked about the Dutch range of products, about what I can safely call our successful distribution system, and about the structure of our promotion organization, the Flower Council of Holland, I would like to deal in more detail with our market position and our activities in the American market.

The Flower Council of Holland has been active for almost a decade in the American market. In late 1981 we opened our own office in New York. The Flower Council of Holland has rapidly become a household name in American trade circles. The aim of the office is to keep American wholesalers and retailers informed about Holland flowers.

The promotion instruments we use are as follows: advertising campaigns in the trade press for retailers and wholesalers; inviting the trade press to visit the annual Professional Flower Exhibition in Aalsmeer; the most interesting professional flower show in the world; direct mailing of our own info magazine "Holland Flower" in an edition of 20,000 copies in the U.S. and Canada; maintaining contacts with American professional organizations by way of personal contacts (FTD, SAF, WF&FSA); distributing promotional material such as posters, catalogues etc; organizing design shows. I would like to expand on this point. Design shows are a form of cooperation between the Flower Council, a Dutch exporter, and an

American wholesaler or importer. They jointly offer the customers of the wholesaler or importer, the florists, a design show at which a Dutch flower designer gives a demonstration with, of course, Dutch flowers, and to inform the audience on care and handling of the products. The Flower Council also coordinates the annual submission to the SAF New Varieties Competition. Finally, the Flower Council is represented at various consumer events such as the Academy Award presentation in Los Angeles, where we organize the flower decorations, and the Pasadena Rose Parade in California. This year we cooperated for the 13th time with this most significant rose event in the world. As a gift from the flower growers of Holland, our top designer, Els Hazenberg, has decorated the official cars in the parade with Dutch flowers, such as the 1932 Packard used by the Grand Marshal, Mr. John Glenn.

In general terms, our promotion activities are organized so as to bring to people's attention the characteristic qualities of Holland flowers, such as the wide range, the excellent quality of Dutch flowers, and the reliable supply. Also very important is reliability in time and uniformity in quality. I speak the truth when I say that our activities have brought about a vigorous development and change in flower sales on the American market. The American consumer is demanding a steadily expanding range, new varieties and species, and is no longer satisfied with the old limited range. Dutch flowers, exotic flowers, have become a real concept in the United States.

The demand for a wider range goes hand in hand with the increase in flower consumption in the USA.

Holland is very happy with this growing market, even though it must regrettably be noted that Dutch exports cannot wholly profit from this for a variety of reasons. I will return to this in a moment.

A structural problem which the Dutch exporters encounter on the American market is the not entirely smooth functioning of the distribution network. The American market is, as yet, often opaque. The unloading of imports at airports could certainly do with improvement. The number of distribution switch-over points between exporter and retailer is often too high. This increases the amount of time that the blooms are in transit and thus has a detrimental effect on their quality. And of course, this adds costs to the price and makes our position weaker.

What is our position on the American market? The US market, in general, is increasing by 8 percent every year if calculated in dollar value and approximately 7 percent in volume. The reasons that the Netherlands can not fully profit from this autonomous market growth are, in the first instance, that in answer to the demand created for a broader range, the American local producers have begun to widen their range and deepen it. The value of local production has increased almost twofold during the last five years. The increase in production is equally valid for the countries of Central and South America, especially for Colombia, which has a strong hold on the American market. Secondly, the fall in the dollar exchange rate has, during the last few years, had a negative influence on our exports to the USA.

Dutch exports developed as follows during the last five years:

Development of Dutch exports

	$ million	million stems
1984	90	149
1985	123	244
1986	100	221
1987	84	209
1988	78	194
1989	87	212

In comparison with 1988, the flower export to the USA in 1989 has recovered well but is not at the level of some years ago. In the top year of 1985, about 10 percent of the total Dutch cut flower exports was destined for the USA. In 1989 the proportion had dropped to about 6 percent. Four products predominate among Dutch exports to the USA and take up nearly 70 percent of the total: freesias, irises, lilies and of course tulips. By volume these products constitute the following percentage of imports into the USA.

Dutch import proportion in the USA

Freesia	93%
Iris	97%
Lilies	80%
Tulips	96%

Because of the local competition mentioned above, and the imports from Central and South America, the percentage of lilies has dropped during recent years. This has occurred to an even more significant degree with alstroemerias and gerberas.

Should we conclude here that the role of the Netherlands on the American market will decrease structurally? Surely not. The dollar rate is stabilizing and even shows a tendency towards rising. This will benefit our exports to the USA.

A more important argument, however, which gives us confidence, is the element of the mix of quality and composition of our assortment. The Netherlands is permanently ahead of other countries as regards range, thanks to our rapid product renewal. In comparison with our competitors, we have a broader and deeper range. In the final analysis, Dutch flowers have an excellent image with both retailers and consumers. The positioning of the Netherlands as a speciality supplier gives us our own place in the American market.

To summarize my lecture: Holland owes its leading role as flower exporter to the three following elements:

The wide range of products we deliver and the high quality of these products. Research is a very important factor for supporting our position.

The structure of our distribution system that permits an efficient and fast operating connection between supply and demand.

The unique organization of our promotional activities where all Dutch market parties join in combined efforts.

And as regards the American market, even though this market confronts us with a number of problems, the quality and variety of our product gives us all confidence in maintaining our place as speciality supplier.

Thank you.

IMPORTATION AND DISTRIBUTION OF FLORAL PRODUCTS INTO JAPAN[1]

by
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Without question, Japan in 1990 is a world class economic power. Their per capita income is the highest in the world. The top ten banks in the world are Japanese owned. Seven of the top ten public companies in the world are Japanese owned. Savings per family is the highest in the world. Trade surplus is the largest in the world. Japanese firms are purchasing property and companies throughout the world. Manufacturing facilities are being built by Japanese firms all over the globe, and they have been enormously successful. The Honda plant in Ohio is a prime example. They are now "exporting" autos to Japan and will soon begin exporting autos to Europe. The gross income of the largest company in Japan exceeds that of the entire nation of The Netherlands.

This economic status Japan holds has not been all positive. Americans, prior to the changes that have and currently are still occurring in Eastern Europe, responded to a survey that they are more concerned/threatened about Japan's economic might than the military arsenal of the Soviet Union. Japan bashing in the newspapers, radios, television, and magazines worldwide is increasing daily. It is the protectionist posture of the Japanese that is the core for the bashing. To be certain, there are two sides to the matter. However, when the Japanese consumer pays $3 for an apple, $60 per pound for strip steak, many times more for a pound of rice than Americans, and can purchase items made in Japan cheaper in the U.S. than in Japan, all is not right.

Paul Harvey, on March 10, 1990, bashed the Japanese relative to the new emperor's planned coronation as a god. On a personal note, the Japan bashing has affected me and my family.

With all its economic power, the so-called quality of life in Japan may not be what we in the U.S. believe it should be. They work hard and long hours. The cost of housing and land is unbelievable. Many Japanese must commute at least one hour to work because housing is too expensive near a city. Tokyo is impossible. Living quarters for most families are very small. But, are they happy?

Make no mistake, excellence in quality is paramount in Japan. This fact encompasses every product they purchase, including flowers. This fact also causes enormous problems for producers and distributors who wish to enter the Japanese marketplace. Entering the marketplace in Japan might be worth considerable effort from a financial standpoint. A case in point is what the Dutch had to do to enter the Japanese flower marketplace.

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[1]Professor Tayama's text was adapted from an outline he provided.

Current Status of the Floriculture Production Industry in Japan

In 1988, it is estimated that 13,976 hectares (34,535 acres) was devoted to the production of fresh cut-flowers. This figure is 23.4 percent of the total for the world. Many flowers are produced in non-heated greenhouses or outdoors. Future expansion: there are new greenhouses being constructed.

Table 1. Current fresh-cut flower production area in Japan

Crop	Hectares	Acres
Rose	344	850
Carnation	456	1,226
Chrysanthemum	4,864	12,014
Orchid	65	161
Gladiolus	307	758

Population, Retail Flower Outlets, and Per Capita Flower Consumption

Japan is currently the seventh most populous nation in the world: 123.9 million. By the year 2000, a United Nations study estimates Japan's population will increase by 11 percent to 129.7 million, which will put it in eighth place. In 1988, Japan had 24,515 retail flower outlets or approximately 190 per every one-million people. This number is higher than the U.S. (147), but lower than The Netherlands (759), Belgium (556), West Germany (328), and Switzerland (313).

Japan's per capita consumption of fresh-cut flowers in 1988 was $40.00. This number is not comparable to the rest of the world because of the much higher cost of flowers in Japan. All of the data we receive from Japan are in yen, not stems.

Auctions and Distribution Systems

There are a total of approximately 340 flower auctions in Japan. Ninety-nine percent of all fresh cut flowers are sold through the auctions. Only a few auctions handle potted plants. Many potted plants are sold directly to retailers. There are 11 central auctions, 238 local auctions that cover more than 2,150 square feet each, (200 square meters), and 91 local auctions that cover less than 2,150 square feet each. The largest auction will gross approximately $11,400,00 per year and the smallest $1,400,000 per year. The auction can be best and most kindly described as chaos.

Table 2. Import of fresh-cut flowers and cut foliage by Japan in millions of U.S. dollars.

Export Country	1985	1987	1988	Product
Thailand	16.5	23.9	30.2	Orchid
Holland	2.8	12.0	27.4	Freesia, lily, rose, carnation
Taiwan	6.2	6.7	10.8	Chrysanthemums, gladiolus, fern
New Zealand	2.6	5.3	7.4	Orchid
Australia	0.7	2.4	5.7	Waxflower, kangaroo-paw
U.S.A.	4.8	3.9	4.0	Fern, bear grass
Singapore	2.4	2.9	4.4	Orchid
S. Africa	0.1	0.3	0.7	
Malaysia	0.4	0.2	0.4	
Spain	0.2	0.7	0.5	
Others	1.3	1.3	2.0	

Table 3. Import of fresh-cut foliage by Japan in millions of U.S. dollars.

Export Country	1985	1987	1988
U.S.A.	1.5	2.5	3.3
Taiwan	1.1	0.7	0.8
Costa Rica	-	0.1	0.7
Italy	0.2	0.1	0.1
Australia	0.02	0.1	0.1
India	0.1	0.1	0.1

Japan produces many of its own cattleya orchids. Orchids from Thailand, Singapore, New Zealand. Gladiolus from Taiwan. Chrysanthemum from Taiwan. Insufficient production of certain crops: nerine, freesia, lily, tulip from The Netherlands. No production: waxflower and kangaroo-paw from Australia.

MARKETING ORCHIDS FROM SOUTHEAST ASIA TO EUROPE AND AMERICA

by
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It is clearly evident that Thailand is the most successful country in the export of orchids to the world among the countries in Southeast Asia. The volume and value can be seen from these statistics.

Table 1. Quantity and value of orchid flowers and plants exported from Thailand.

Orchid flowers

Year	Quantity (ton)	Value US $ (1000)
1987	7090.00	16,356
1988	9531.94	20,632
1989	8670.47	16,207

Orchid plants

Year	Quantity (ton)	Value US $ (1000)
1987	594.30	1,123
1988	817.62	1,530
1989	814.15	1,720

Source: Thai Customs

Evaluating this data, orchids from Thailand still maintain popularity and are in top demand in Europe. However, the Japan market is expanding rapidly. When it started to import in 1975, we represented almost half of Thailand's export.

U.S.A. markets have imported for a long time, but the number is still relatively low compared to the large population. Most of the consumed flowers are for public use.

Table 2. Quantity of orchid flowers exported from Thailand (tons).

Japan	2,654.36
Europe	2,629.45
U.S.A.	384.83
Taiwan	50.27
Canada	44.31
Australia	26.97
Others	303.71

Table 3. The import value of flowers from The Netherlands (value: $1,000.00).

Exporter\Year	1982	1983	1984	1985	1986
Singapore	979	857	680	404	355
Thailand	3,622	3,517	3,293	3,155	3,544

Source: ESCAP

Table 4. U.S.A. import of orchids from Southeast Asia (value: $1,000.00).

Exporter\Year	1982	1983	1984	1985	1986
Singapore	286	522	716	1,455	402
Thailand	984	1,600	2,266	1,901	2,388

Source: US General Imports and Imports for Consumption

From the above statistics, the leading shipper is Thailand due to several factors: geographic and climatic conditions fit for the cultivation practice; improvements of new varieties; the demand of Japan, Europe, and U.S.A. make year round production and selling cut flowers profitable farming; there is an abundant work force and plenty of land; there is an increase of tissue culture laboratories in the private sector and higher technology of government research programs; many experienced orchid growers and cheap and abundant growing material with a good water resource.

These are five major factors that make Thailand the leader in exporting orchids from Southeast Asia.

1. Product.
2. Price.
3. Transportation.
4. Political stability and Modern Export Outlet.
5. Competitive among Asian Countries.

Product

During King Rama V around the year 1920, 40 *Dendrobium* 'Pompadour' seedlings were imported from France. Two of them were selected to be good cut flowers and expanded rapidly into millions of plants by cutting. Export of cut orchids became very active when enough numbers of 'Pompadour' could be produced and quality improved to meet the market standard. Thank goodness for the 'Pompadour' and its long lasting packing quality and amazing lilac color. Between 1975-1980, 'Pompadours' were in great demand in the major world flower markets like Holland and West Germany.

Together with 'Pompadour', D. 'Caesar' and some white 'Jaquelyn Thomas', 'Walter Omae' and some yellows were exported.

Percentage of demand in color can be estimated at 70 percent lilac ('Pompadour'), 10 percent whites, 10 percent 'Caesar' and 10 percent others.

During 1980, 'Pompadour' had been in the market too long and there was some over production that brought the price down sharply.

It is luck and good effort that make Thailand able to produce the new generation of pinks and red-pinks in 'Bom' or 'Sonia' and others related. The market accepted these very well mainly due to the lasting quality and attractive colors.

If we look back from 1990 to 1970, movement of orchid exports can be divided into four cycles, each of five years.

1970-75--Slow with improvement on packing techniques that would set the world standard.

1975-80--Fast growing due to good quality and good world economics.

1980-85--Overproduction and being too long in the market with the 'Pompadour' caused demand to decline sharply and nearly end the business.

1985-90--Business came back to normal because of new varieties, world economic recovery, and more demand in the U.S.A., with increasing demand from Japan.

Increase of export value from 1982-1986 can be seen from this table.

Table 5. Quantity and value of the orchid flowers exported from Thailand, 1982-1986 (value: millions of dollars).

	1982		1983		1984		1985		1986	
	Ton	Value	Ton	Value	Ton	Value	Ton	Value	Ton	Value
Japan	1266	2.80	1403	3.80	1682	4.50	2164	7.3	2655	7.5
U.S.A.	145	0.36	323	0.56	418	0.77	574	1.0	385	0.72
Europe	3735	7.70	4595	7.10	3978	7.60	3574	8.3	2193	5.60
Others	1177	2.30	1592	2.60	1403	2.60	1469	2.7	822	1.50

Source: Thai Custom

Export to U.S.A. markets started from 1975, but the rate of increase does not go as fast as in Europe or Japan due to some factors: Strict plant quarantine control, abundant number of local production, nearby new production areas like Columbia, and most of the orchids demanded are for public and not personal use.

Price

Price of Thai orchids in the world market is very competitive compared to the same type that is imported from Singapore or Malaysia. The reason for this is that they are mass produced at a lower cost in Thailand.

Postharvest handling technology is being developed by both Thai research institutes and also on the advice from Dutch importers to Thai exporters. Several techniques are performed at the present time: fast transport from the farm (modified from the Dutch container style), pretreatment by ethylene block chemical in the cool room at 20^{o}C before packing, preservative material applied in tube while being transported, fumigation technique also improved, using pure methyl bromide circulated thoroughly. New export packing houses are equipped with modern facilities since the volume of business is large enough due to company management style, rather than co-op farm packing houses like the Singaporian style; flowers are well graded; conveyer belts are also used; boxing is in air-conditioned rooms almost like the precool system; and shipments are well organized and transported by forwarding agent's trucks.

Transportation

Due to good world economics, passenger and cargo business becomes a golden time for airlines. Lack of space or some small payloads result in many flowers not being exported. An estimate of 70 percent of the flowers can be shipped during the high season. The price is still cheap although the demand is still strong. Problems may go on until modern and powerful aircraft are released to the demand.

Political stability

Asian political stability has become stronger with high percentages of economic increases. This shows signs of the market expanding as a possibility. Market shares in the world market are expected to increase more for all products.

Other types of orchids like vanda, arachnis, aranda, and others still have regular demands for some type of consumers as long as varieties are always improved.

Competition among Asian Countries

Singapore. Although Singapore can produce the best quality of orchids, there are so many factors that limit the growth: lack of government support, farm lands taken away for use of higher yield products, and limited laborers.

Indonesia and Malaysia have suitable location but lack of good farm management and skillful laborers.

The Philippines can produce good orchids but lacks political stability.

Thailand

Present and future are still bright, with many types of orchids that can be developed for export and can be expanded to the sale of young orchid plants, and other types of cut-leaf ornamental plants.

POSTHARVEST HANDLING OF HAWAII CUT FLOWERS FOR EXPORT

by
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The expansion in the production of Hawaii flower and nursery products has increased the need for optimum postharvest handling. Optimum postharvest handling is essential for the maintenance of quality and vase life. This maintains and increases Hawaii's market penetration by providing cut flowers handled by procedures that ensure minimum shrinkage and maximize consumer satisfaction.

All Hawaii cut ornamentals are currently shipped by air. These air shipments are made by air mail, air post, and air freight. The increasing cost of air shipments is a major concern. It may be possible to ship the hardier ornamentals, such as anthurium, bird of paradise, and ti leaves, by surface transportation. This would not be possible with the more delicate flowers such as orchids.

Physiology of Cut Flowers

At harvest, the flowers' source of water, ions, and sugars is violently broken off. This loss of supply is modified in the postharvest handling of flowers by the ability to supply water and some of the nutrients in the vase solution. However, there is no selective absorption capacity, and only the upward movement of sap now occurs. Cut flowers, because of their wide diversity of tissue types, have widely different nutrient requirements that add complexity to handling.

A major concern in cut flowers is, therefore, the sap-carrying tissue or xylem vessels. In general, the rate of water uptake declines after harvest. The rate of decline in water uptake can be reduced by appropriate use of water amendments and preservative solutions. The cause of the decline in water uptake is thought to be due primarily to microbial contamination that blocks the xylem vessels. An alternative explanation is the plants' response to wounding.

Factors Controlling Quality

There are four major factors controlling quality, including postharvest life:

1. Preharvest factors determine 70 percent of the postharvest lasting qualities;
2. ethylene sources must be eliminated or reduced;
3. storage temperature control is a must; and
4. the importance of relative humidity control has to be understood and implemented.

1. Preharvest Factors. It has been estimated that up to 70 percent of the potential lasting quality of many floral crops is predetermined at harvest. These preharvest

factors are related to the production of the crops. Production factors can be categorized into inherent or genetic, environmental, and management factors.

a) *Genetic,* cultivars released by the University of Hawaii do undergo testing for potential postharvest lasting quality.

b) *Environmental,* either controlled by nature or man, can significantly alter the quality of a product. Low light can result in a reduction in food being produced via photosynthesis, often resulting in crops that have inferior lasting qualities. The vase life of mainland-grown chrysanthemums flowered in November and December under full light conditions was only two days longer than flowers grown under 50 percent shade at the same time. However, these differences increased to five to seven days when harvested in mid-summer. Too high a growing temperature can reduce postharvest quality. For example, three varieties of roses were grown at 15, 18, 21, 24, and 27° C. The roses grown at 21° C had the longest vase life.

c) *Management* is a major production factor. Over-fertilization can decrease the quality of many floral crops. Frequently, as nitrogen levels increase, lasting quality decreases. Another major factor is time of harvest, which is dependent on a number of factors including stage of maturity, distance to market, customer characteristics, consumer demand, and time of year. Examples of keeping qualities of certain fresh flowers harvested at different maturities is given in Table 1.

Table 1. Examples of lasting qualities of some fresh flowers harvested at different maturities.

Crop	Harvest maturity	Lasting quality (days) From harvest	Lasting quality (days) From fully open flowers
Carnation	open	10.4	10.4
	bud-cut (calyx opening)	15.2	13.2
Chrysanthemums	open	14	14
	bud-cut	19	8
Anthuriums	Mature spadix	44	
	1/2 mature spadix	38	

2. Ethylene. Ethylene is a low-molecular-weight gas that is notorious for reducing the quality of floral crops. Common examples include carnations going to "sleep," shattering of snapdragon flowers, dry sepal injury and shedding of orchids, blueing and shedding of anthuriums, and yellowing and/or shedding of foliage of container grown plants. It is imperative that every step be taken to eliminate or reduce ethylene in areas where floral crops are being handled. Levels of 30 to 60 parts per

billion may cause reduction in crop quality, especially fresh flowers, while higher levels (approx. 1.0 ppm) are needed to injure foliage plants. The vase life of anthuriums can be reduced almost in half by a short exposure to ethylene (Table 2). Dendrobium orchids are much less sensitive to ethylene than vanda orchids but they are still sensitive. Chrysanthemums and tulips appear to be relatively insensitive. Anthurium would fall between these two extremes.

Table 2. Total vase life of anthurium 'Ozaki' dipped into 100 ppm ethephon, a chemical which breaks down to ethylene; mean of 12 flowers per treatment; treatment differences are statistically significant.

Treatment	Vase life (days)
Control	21 a
Ethephon dip	13 c
Ethephon dip + ethylene inhibitor (AVG)	18 b

Values within a column that are not followed by the same letter are significantly different statistically.

There are numerous sources of ethylene. The following briefly summarizes some of the major sources:

a. Most probably all floral crops biosynthesize ethylene; enough is frequently produced to cause their own flower drop (e.g., orchids). The most dramatic example is the ethylene production rate of 30 ml/g/hr from pollinated vanda orchid blooms compared to undetectable levels for ones not pollinated.

b. Fruits and vegetables also produce ethylene. Therefore, mixed storage with these crops should be avoided.

c. Diseased and injured plants as well as some common pathogens produce ethylene.

d. Internal combustion engines, both propane and gas powered, are a major source of ethylene in the ambient atmosphere. Levels up to 700 parts per billion have been measured in city atmospheres; a more normal range would be 5 to 30 ppb.

e. Various electric motors and fluorescent light ballasts under extreme conditions release ethylene from the insulation.

Treatments which delay water loss and wilting stresses delay or suppresses ethylene rise. One of the most useful compounds is silver. Silver thiosulphate (4mM, 10 minutes) is widely recommended for carnations and can double carnation longevity. The so-called "Super-Carnation" publicized in trade papers has been treated in this way. A short dip in silver nitrate solution (4mM, 10 minutes) in our studies was better for anthuriums (Table 3) than silver thiosulphate. Silver treatments have not given any extension in postharvest life of dendrobium orchids.

Table 3. Anthurium and dendrobium shipping and vase life as effected by different silver treatments. Anthurium were packed for three days after treatment and dendrobium two days.

Treatment	Anthurium Vase life (days)	Dendrobium Vase life (days)
Control deionized water - no packing	7 d	19 b
Control packed	13 c	23 a
Ag NO_3 packed	22 a	21 ab
Ag S_2O_4 packed	19 b	21 ab

Values within a column that are not followed by the same letter are significantly different statistically.

Silver nitrate and silver thiosulphate sprays may be useful in preventing blossom loss and leaf shedding in potted plants. This could be done possibly up to a week before shipping. The cost for a 6" pot would be less than 0.1 cents at the concentrations used.

3. Storage Temperature. Temperature is for many floral crops the most important single easily controlled factor. As with all perishables, the rate of development and senescence of ornamentals is strongly influenced by temperature. The respiration rate, a measure of metabolic activity, of carnation increases 25-fold from 0 to 20° C.

Ornamental plants from tropical and subtropical regions may be deleteriously affected by temperatures below about 10 to 12° C. Chilling injury occurs below these temperatures; in anthuriums it is expressed as darkening of the flower spathe and spadix. In orchids the injury is manifested by a darkening of the column which later spreads to the labellum (lip) and then to the sepals and petals. There are exceptions; certain *Cymbidium* cultivars can be successfully stored at 0° C.

4. Relative Humidity and Water Relations. Unlike most other perishables, cut ornamentals are exceedingly sensitive to desiccation, having a high surface area in relation to their volume. Normally, loss can be replaced from vase solutions. A prime example of desiccation is "bent neck" of cut roses, where the water needs of the foliage and flower are provided at the expense of the relatively soft stem tissue just below the flower.

Movement of water in the stem is strongly affected by the composition of the vase solution. Acidic solutions are better than neutral and alkaline solutions. "Plugging" of the cut stem, whether by microbial contamination of the vase solution, particulate or colloidal material in the water, or exudations of the cells surrounding the conducting tissues in the stem, is considered to be a major limitation to the vase life of many cut flowers. Anthurium vase life is probably limited by plugging of the stem, and the silver nitrate treatment mentioned above probably reduces this event.

High relative humidities can help extend lasting qualities of floral crops by conserving water loss via transpiration. Moistened shredded newspaper in flower boxes effectively does this. It is preferable to store all floral crops at 90 to 95 percent relative humidity.

Postharvest Handling

1. Insect Disinfestation. The presence of insects on cut flowers and foliage is a major problem in the export trade. Consignments found with live insects by importing country inspectors can be fumigated or destroyed. A rejection of a consignment results in a fee for a fumigation that could damage the flowers. Methyl bromide and hydrogen cyanide are the most common chemicals. The extent of the problem can be gauged from some of the cut flowers arriving in Japan (Table 4).

This disinfestation problem is being addressed here by Drs. Arnold Hara and Harvey Chan. Their objective is to determine the sensitivity of Hawaii flowers to different disinfestation methods. There are a number of possible methods (Table 5). Most of the methods are effective in killing the insect, but the patient also dies. In other cases, there is severe loss of postharvest life and flower quality. Hydrogen cyanide is showing the most promise.

Table 4. Plant quarantine inspection data for selected cut flowers imported into Japan in 1986.

Flower	Number stalks inspected ('000)	(%)	Number destroyed ('000)
Orchid	79,077	35.5	48
Anthurium	5,815	7.0	2
Protea	134	58.9	0

2. Packaging. The purpose of packaging is for the convenience of marketing. The package has to meet a number of requirements: (1) protection from injuries, (2) temperature management, (3) protection from water loss, and (4) facilitate special treatments. For Hawaii, the first two requirements are paramount, as much of our problems have to do with air-shipped boxes being exposed to high and low temperatures. These high and low temperatures cause injury to the flowers. There is considerable variation in the ability of various packages to protect against temperature extremes (Table 6). In this experiment, standard flower boxes (39" x 21" x 7") with covers were used. Boxes were exposed for 36 hours at 39° F (4° C) followed by 12 hours at 72° F (22° C). The corruguard box was most effective.

Table 5. Potential insect disinfestation treatments.

Treatment	Method	Phytotoxicity
aerosols	pyrethmin dichlorvonone	none
fumigant	methyl bromide hydrogen cyanide phosphine	variable variable ?
insecticide dips	carbaryl dimethoate permethrin	low
irradiation	gamma	severe
temperature	low heat vapor heat	severe severe ?
combination	low temperature & carbon dioxide	moderate

Table 6. Effect of different packing methods on the development of anthurium chilling injury symptoms and half cooling time at the center of the carton.

	Chilling Injury	$t_{1/2}$ (hours)
Standard box (unchilled)	1.4 d	--
Standard box (chilled)	3.3 a	2.2
Corruguard (chilled)	1.7 c	8.2
Standard box wrapped 1/16" foam (chilled)	2.1 b	6.5

Values within a column that are not followed by the same letter are significantly different statistically.

Handling of Hawaii Flowers

Anthuriums

There is conflicting evidence as to whether it is bacterial or physiological blockage of the vascular tissue that reduces postharvest life. Both causes can be reduced by proper postharvest handling.

Maximum postharvest life occurs when flowers are harvested when 3/4 or more of the flowers on the spadix are open. Two postharvest treatments have been found to increase postharvest life: treating the recently cut stem with 1000 ppm silver nitrate for 10 to 20 minutes, or waxing the flower with 3 percent carnauba wax (Table 7).

A major problem is temperature extremes during shipping. Flowers should not be exposed to temperatures less than 50° F for more than one day. Packing material can reduce the risk of injury during shipping.

Table 7. Effect of various treatments on anthurium postharvest life.

Treatment	Life (days)
Control	13 c
$AgNO_3$	26 a
FMC-819 wax	21 b
$AgNO_3$ + FMC-819 wax	22 b

Values within a column that are not followed by the same letter are significantly different statistically.

Bird of Paradise

As with heliconia and ginger flowers, bird of paradise shows similar symptoms of loss of life, including flower wilting, darkening of the base of the bract, and leaf curling. The cause is a rapid loss in water uptake ability associated with blockage of the stem vascular tissue. Recutting of the stem is essential at the retail level.

This is a subtropical plant not as sensitive to cold as heliconia, anthurium, and ginger. Short-term exposure to 38-40° C is possible but not recommended for long periods. Symptoms of injury include brown lesions on the bracts. Store preferably in water at 45-50° F. Pulsing of flowers can be used to improve opening and postharvest life. A 24-hour treatment of 10 percent sucrose with 250 ppm 8-hydroxyquinoline citrate and 150 ppm citric acid is recommended. Mold in the sprays can be reduced by fungicide treatment (200 ppm TBZ or Benomyl). When packing, it is advisable to be sure the spray is dry and without nectar or wet fungicide residue. Too moist conditions in the package can lead to mold conditions.

Dendrobiums

The common symptoms of flower senescence include darkening of flower, shrivelling, and finally shedding. The cause is apparently reduced water uptake. The water uptake rate by individual sprays is very low, on the order of < 0.1 ml/hour.

There is some cultivar variation in postharvest life. Immediately after harvest, flowers may be soaked for five minutes or so. This soaking should not be repeated at the other step in the handling chain. Attention should be paid to having the

flowers dry before packing; avoid free water between plastic sleeve and flowers. This can lead to problems in transit. Unlike certain orchids, e.g., vanda, dendrobiums are much less sensitive to ethylene, but sprays should not be unnecessarily exposed to the gas. Sprays should not be stored below 50° F for any period of time. Sprays can be held at 50-55° F for up to one week. The relative humidity should be in the range 90-95 percent.

Red and Pink Ginger

Inrolling of the leaves and darkening of the bracts are major symptoms of flower senescence. These symptoms are associated with reduction in water uptake due apparently to plugging of the water-conducting tissue.

Stem size and bract development are the two critical factors affecting postharvest life. Larger diameter, longer stems generally have longer postharvest life. Fairly compact and not completely expanded inflorescences are less susceptible to pest infestation and shipping damage. Since these are tropical flowers, do not store them at temperatures less than 7° C. It is also necessary to store vertically, as geotropism can be a problem. Ginger must be kept at high humidity (90-95 percent) and in water to prolong life. Stems should be recut to extend storage life. Silver treatment has a slight effect, with waxing giving variable response.

Heliconia

Symptoms of old flowers include darkening at the base of the bracts and drying of bract tips. The cause of reduced postharvest life, besides cultivar differences, is reduced water uptake.

Heliconia are more chilling sensitive than ginger and bird of paradise and should not be stored below 55° F. Storage time should preferably be less than two days. There is considerable cultivar variation in postharvest life (Table 8). Stems should be placed immediately in water after harvest. Flowers should not be packed wet, and every effort should be taken to avoid mechanical injury. Mold control can be obtained by a dip in 200 ppm TBZ or Benomyl. Heliconia show little response to preservative solutions. Silver treatment has no effect, with only small response to waxing.

Table 8. Variation in postharvest life of small heliconia cultivars.

Cultivar	Vase life (days)
Fireflash	4 to 7
Emerald	5 to 10
Golden Torch	7 to 14
Petra	10 to 14
Sybille	10 to 20
Nickeriensis	14 to 21

Source J. Powell. 1989.

Protea

The major problem is the postharvest leaf blackening in 'Pink Mink' (*Protea neriifolia*). There is considerable cultivar difference in the rate of leaf blackening. The susceptibility to blackening is also dependent upon preharvest conditions. High sunlight before harvest and harvesting in late afternoon reduce the susceptibility to blackening. Flowers should be harvested at the soft tip stage, when the bracts are beginning to open and loosen, to prevent initiation of nectar production by the flowers. The nectar production can lead to the flowers becoming wet and sticky during packing. After harvest, flowers should be held in water. Avoid mechanical damage to the leaves and strip only the minimum number of leaves. Flowers should be held at 40° F and 90-95 percent RH. Preservative solutions help reduce leaf blackening. Darkness enhances leaf blackening.

Summary

Cut flowers are living, actively metabolizing plant parts, subject to the same basic aging phenomena as are entire plants. Water is the first and self-evident need of cut flowers; the quality of this water can be important. Proper temperature management is essential to slow down the aging process. Ethylene exposure should be avoided, and in this regard a number of chemicals are available, including commercial preservative solutions and silver ions. Preharvest factors play an important role in postharvest life.

PEST-RELATED FLOWER SHIPMENT REJECTIONS

by
W. Dean Gardner
Western Region, USDA-APHIS-PPQ

PPQ Mission

Protecting the United States from pests and diseases that may be harmful to U.S. agriculture. Many of these pests we know do occur in foreign countries and do not occur here in Hawaii or on the mainland.

Enabling Legislation and Regulations

Legislation enacted by Congress and the President gives PPQ the authority to carry out the mission of protecting American agriculture from plant pests. The legislative acts passed by Congress are the legal basis for PPQ's existence.

1. Plant Quarantine Act. Allows the Secretary of Agriculture to promulgate quarantines that restrict and prohibit the entry of host plants, plant parts, and products in order to protect U.S. crops from specific plant pests and pathogens.

2. Federal Plant Pest Act. Regulates the entry of any organism that can directly or indirectly injure or cause disease in plants. This act also regulates any article or means of conveyance that could carry pests. This act gives authority for emergency action and for issuing regulations necessary to prevent the pests' spread. FPPA provides authority to board ships and planes and to restrict the entry or require the treatment of any cargo that may be infested with pests.

3. Federal Seed Act. Restricts entry of agricultural and vegetable seeds to ensure seed purity and that the seed is free from noxious weeds.

4. Federal Noxious Weed Act. Restricts entry of seeds that are determined to be harmful to agricultural crops, livestock, fish and wildlife, or public health.

5. 318.13--Hawaiian Fruits and Vegetables. Restricts and prohibits the movement of fresh fruits, vegetables, cactus, cut flowers, mango seed, and rice straw from Hawaii to other parts of the United States.

Inspection

Determination of which material to inspect is a judgment call. Obviously, with the volume, it is impossible to inspect 100 percent of all plant material. PPQ officers select samples for inspection. It is not absolute but rather a judgment based on the officer's experience. We allow the officer on the location as much flexibility as possible. Officers tend to develop a kind of sixth sense as to which material to

inspect, where to look, and how to inspect. Officers look for symptoms of disease, blotches, and darkened areas on the plant, leaf miner damage, or trails. They look for evidences of insects. Officers use a shake-and-rattle procedure on a white background to loosen an insect pest from the material.

If officers find pests they cannot identify, pests must be submitted to trained entomologists or plant pathologists for identification. Honolulu has both an entomologist and plant pathologist. If they cannot identify the pest, then it is sent URGENT to specialists at Beltsville, Maryland.

Plant material many times cannot wait any length of time for decisions, so most decisions are made on site where inspections are conducted.

The most prevalent pest found by PPQ Officers, as well as California inspectors, have been: aphids, scales, mealybugs, white flies, thrips, lepidoptera larvae, and ants. Lepidoptera larvae and thrips will cause shipments to be held until identified. White fly adults in shipment result in an automatic rejection, as we need to have the immature state for identification.

California inspections procedures are much the same as the federal ones. They have many pests which are not federal action pests but do require California action. Federal PPQ officers have been appointed as collaborators to enforce the California regulations. Even though PPQ officers here in Hawaii release shipments to California, the California officers have every right to reinspect, hold, or reject a shipment. Rejections can be very costly to the producer.

California pest are rated as A, B, C, D, or Q pests.

A = A pest of known economic importance subject to state (or commissioner when acting as a state agent) enforced action involving eradication, rejection, or other holding action.

B = A pest of known economic importance subject to eradication, control or other holding action at the discretion of the individual county agricultural commissioner, or subject to state endorsed holding action and eradication.

C = Control, or eradication, as local conditions warrant, at the county level. Quarantine or other holding action at the county commissioner.

D = No control or quarantine action at county level.

Q = A pest requiring temporary "A" action pending determination of permanent rating. The organism is suspected to be of economic importance, but its status is uncertain because of incomplete identification or inadequate information.

Q-rated pests will cause rejection of infested material or the pest as such, when found in a quarantine shipment.

Hawaii Quarantine 318.13 provides conditions for limited permits to be issued for movement of articles in accordance with the regulations. This certification is based upon inspection, and that the articles are found free from infestation and infection, and that it is determined that the shipment is of such a nature that there is no danger of infestation or infection. As a condition of issuance of a limited permit for movement of regulated articles, a compliance agreement is required, and the person applying for a limited permit must sign the agreement, which stipulates that they will use the permit in accordance with the provisions thereof and that they will maintain safeguards against establishment and spread of infestation or infection.

The limited permit stamp contains the statement, "May Be Opened for Inspection." PPQ officers retain the right to spot-check any shipment to verify that conditions of the limited permit are being adhered to. Also, California officers at destination may reinspect shipments.

By use of the limited permit, PPQ is allowing the shipper to conduct the inspection and verify its freedom from pests. If the shipper does not comply with conditions of the compliance agreement, the limited permit is rescinded and the stamp returned to PPQ.

The growth and development of the cut-flower industry in Hawaii has come a long way. A major concern has been the insect and pest problem of many products.

While most producers have been very conscientious in producing pest-free products, there is still need to develop and maintain ongoing pest management programs. These should include early detection of pests and eradication at the grower level. Check with your county Extension Agent or the University for assistance, recommendations, methods, and control measures to use in your pest management program. Pest management programs may vary from product to product.

It is imperative that we all work together in an attempt to alleviate spread of plant pests. We certainly do not want to be the cause of spreading infestations to the U.S. mainland or to other countries of the world.

MINIMIZING SHIPMENT REJECTIONS DUE TO INSECT PESTS

by
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Hawaii Institute of Tropical Agriculture and Human Resources

Recently the USDA Animal and Plant Health Inspection Service has been intensifying its inspection of cut flowers and foliage before shipments are exported out of state. This action was due to an increase in significant pest finds on cut flowers and foliage shipments moving under the Limited Permit stamp.

We are presently conducting research to eliminate insect pests from tropical cut flowers and foliage. The following are suggestions for minimizing this quarantine problem based on our research to date:

Insect control on export shipments will require both field control (growers' responsibility) **and postharvest treatment** (growers' and shippers' responsibility).

Effective field control requires good **cultural practices** including:
(a.) Sanitation. Try to control weeds and remove infested flowers or plant parts and plant debris. Weeds and plant debris harbor insect pests, such as ants, scales and mealybugs.
(b.) Plant spacing. Dense plantings encourage more insect pests. Prune or thin your plantings. Plants will do better and your insect pests will be lessened.

Early detection. Controlling insect pests when they are few in number is much easier than large number of insect pests. As soon as you detect ants, aphids, scales, or mealybugs, take immediate action to control them, either through sanitation or insecticide applications.

Use registered insecticides. The following ornamental insecticides interpreted as having general ornamental labels are available for use:

synthetic pyrethroid	
Mavrik Aquaflow	aphids, mealybugs, soft scales, whiteflies
Tempo 2	beetles, caterpillars, weevils, scales
organophosphate	
Dursban 50WP	ants, caterpillars, mealybugs, scales, whiteflies
Diazinon 50WP	ants, mealybugs, scales
carbamate	
Sevin/carbaryl 50WP	ants, beetles, caterpillars, scales.

Ant control. Ants contribute to larger numbers of aphids, soft scales, and mealybugs, because ants tend to these insects as they secrete a sweet substance (honey dew). Try to control ants using baits, granular insecticides or ground sprays. Controlling ants in your field will also control aphids, soft scales, and mealybugs.

Thorough spray coverage. Spray coverage to the target pest is probably the most important factor that will determine whether an insecticide is effective. Ensure thorough spray coverage. Almost all insecticides available today are contact insecticides, and require good coverage for effectiveness.

Postharvest treatment. Postharvest treatments should be used only as a final "clean up" and not as a primary pest control for scales, mealybugs, or ants on tropical cut flowers and foliage. Insecticidal dips will not kill unexposed mealybugs, thrips, and scales hidden in closed bracts and/or growing terminals. Presently, an insecticidal dip consisting of Mavrik Aquaflow and Safer Insecticidal Soap has shown to be effective against exposed aphids, mealybugs, ants, earwigs, and soft scales. (See "Phytotoxicity of Mavrik Aquaflow and Safer Insecticidal Soap When Used as a Dip on Cut Flowers and Foliage" by V. Tenbrink, J. Hansen, and A. Hara, this proceedings.) We are presently investigating alternative postharvest treatments. Hydrogen cyanide (HCN), a fumigant, was found effective against insect pests and safe on tropical flowers and foliage (see "Recent progress in the control of insect pests on tropical floral commodities" by J. Hansen, A. Hara, and V. Tenbrink, this proceedings). However, registration of HCN as a pesticide for use in Hawaii will be a major bottleneck. Other alternative postharvest treatments that will be investigated include other insecticides with fumigant action and the use of hot water dips and vapor heat.

Precautionary Statement

Use pesticide safely. **Follow the pesticide label.** Consult Cooperative Extension Service or Hawaii Department of Agriculture personnel for authorized special local need registrations or additional information. The user is responsible for proper use and application of pesticides as well as storage and disposal.

Disclaimer

Reference to a company or product name does not imply approval or recommendation of the product by the College of Tropical Agriculture and Human Resources, Cooperative Extension Service, University of Hawaii, or the United States Department of Agriculture and does not imply its approval to the exclusion of other products that may be suitable. All materials should be used in accordance with label instructions or manufacturers' directions.

RECENT PROGRESS IN THE CONTROL OF INSECT PESTS ON TROPICAL FLORAL COMMODITIES

by
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Introduction

National quarantine regulations require Hawaii floral producers to ship only insect-free flowers and foliage. Failure to comply may result in severe penalties, such as fines and loss of shipping privileges. Thus, the emphasis to produce clean floral commodities is the daily challenge for Hawaii growers. Insects can be controlled in the field or eliminated by postharvest treatments. Each strategy requires its own set of criteria along with economic, environmental, and safety restraints. The decision to control pests in the field is also dependent on species type and population levels of the pest.

Field Control

There are many approaches to controlling insect pests in the field. The most prominent is chemical application. Determinants in selecting chemical control include cost and frequency of application, effectiveness of the chemical on the target pest, and formulation. First, the cost of application should be less than the economic gain; the grower must make a profit to stay in business. Application should be initiated when the pest population reaches the "economic threshold." That is, when the cost of application equals the amount of economic damage caused by the pest. Hara et al. (1990) recently analyzed control costs for anthuriums when managing pest populations. Insects vary in their susceptibility to pesticides, both among species and even within the same species. Pesticides should be evaluated for their efficacy (Hata and Hara 1989a, b). Formulation is important; foliar sprays are not appropriate in wet, windy environments. Under these conditions, the granular form may be more appropriate. Pesticides should also be examined to determine if they cause plant injury (Hata and Hara 1988a, b; Hara et al. 1988) and to measure their impact on production (Hara and Mau 1986). Insects often interact with each other. For example, ants "herd" and protect aphids, mealybugs, and scales. Removing the ants make the pest insects susceptible to predators and parasites. Hence, selective chemical control of ants results in the reduction of associated pests, too (Hara 1986). Cultural control and field sanitation often lessens insect problems. Maintaining a clean growing environment reduces shelter and alternate feeding sites for insect pests, and hence lowers their population. This is one approach we encourage. One grower using this method rarely applies pesticides, yet produces clean ginger flowers. Thus, prevention may be the best control. Incorporating biological agents into one's management system can also reduce pest populations. Many pesticides, like Dipel and Thuricide, are based on insect pathogens. Other

pathogenic organisms, such as nematodes, are beneficial in controlling insect pests. We are studying the use of nematodes in controlling leafminers in chrysanthemums.

Encouraging natural enemies is also helpful. Parasitic wasps attack aphids, scales, mealybugs, and whiteflies. Insect predators, such as ladybird beetles and lacewings, can be effective. The use of natural enemies to control insect pests is increasing. Biocontrol has been used in The Netherlands to protect subtropical plants in greenhouses (Kole and Hennekam 1990). Field control of insect pests improves product quality and reduces the necessity for postharvest treatments. If these pests can be eliminated in the field, quarantine security is obtained. However, in fact, this rarely happens. No matter how much effort and money goes into field control, not all insects can be eradicated. This is not a sign of failure, but rather a reflection of how persistent insects are. Furthermore, some floral crops are gathered from the wild where there is no intentional insect control. Hence, methods to rid commodities of insects after harvest methods are needed.

Postharvest Technology

An effective method for eliminating insects from cut flowers and foliage is by hand washing. Every piece is examined, and all insects physically removed. However, this method is time- and labor-intensive, which increases costs to the grower. Also, the handling may damage the product and reduce shelf life. At the University of Hawaii at Manoa, we are investigating more efficient methods of postharvest control.

In cooperation with USDA-Agricultural Research Service, we have been examining the use of hydrogen cyanide (HCN) gas as a fumigant. The Japanese treat imported plant material for 30 min at 2500 ppm of HCN. However, there has been some concern about the phytotoxic effects of HCN on tropical cut flowers and foliage (Wit and van de Vrie 1985).

In response to these concerns, we evaluated a variety of Hawaii floral products for plant injury at 2500, 3700, and 4600 ppm of HCN for 30 min. Pincushion protea seemed very sensitive to HCN, and the gingers, 'Ozaki' anthurium, and lobster claw heliconia were affected at the higher dosages (Table 1). The remaining survived the treatments with no immediate damage or reduction in shelf life.

Next, we tested the efficacy of HCN on typical insect pests of tropical plants. HCN fumigation was highly effective against nymphs and adults of the banana aphid, *Pentalonia nigronervosa* (Coquerel) (Fig. 1a), the magnolia white scale, *Pseaudaulacaspis cockerelli* (Cooley) (Fig. 1b), the green scale, *Coccus viridis* (Green) (Fig. 1c), the coconut mealybug, *Nipaecoccus nipae* (Maskell) (Fig. 1d), and other mealybugs, *Pseudococcus* spp. and *Planococcus citri* (Risso), in ginger (Fig. 1e) and exposed on petals (Fig. 1f). Insects that were not controlled were nymphs and adults of the cardamon thrips, *Sciothrips cardamomi* (Ramakrishna), and adults of the orchid weevil, *Orchidophilus aterrimus* (Waterhouse).

Unfortunately, HCN fumigation cannot be immediately implemented. The manufacturer failed to renew the registration of the material, so special procedures

are needed to obtain the official label. Facilities need to be constructed and safety concerns satisfied. Finally, large scale tests need to be conducted. However, these obstacles should not prevent the use of HCN fumigation if it is the only effective treatment for specific pests.

Chemical baths or dips are favorable because they can be easily incorporated into a packing house operation, yet eliminate unwanted insects. We examined several commercial pesticides alone and in combination as floral dips. Mavrik (Fig. 2a) and Tempo 2 (Fig. 2b), both synthetic pyrethroids, were highly effective against the banana aphid, but were less effective against mealybugs (Fig. 2c and 2d). Safer soap and Amway LOC detergent were inadequate for eliminating aphids and mealybugs. However, the Mavrik/Safer Soap was the best of the combination dips (Fig. 2e and 2f). None of these treatments produced injury to red ginger.

Hot water treatments show promise. At 117°F (47°C), hot water was effective against aphids (Fig. 3a), but inadequate for controlling mealybugs (Fig. 3b). However, phytotoxicity tests indicate that red ginger can withstand higher temperatures or longer durations, and research is continuing on effective treatments for mealybugs. Mortality of other insects is also being measured for both chemical and hot water dips.

Conclusion

No single approach will solve all insect problems. Each pest situation is unique and must be evaluated separately. Eradicating insect pests in the field is preferable but not always possible. Postharvest treatments will be needed to ensure elimination of insects from field grown commodities, including those collected from the wild. Research is progressing in the development of effective postharvest treatments for Hawaii cut flowers and foliage.

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Table 1. Phytotoxicity of various tropical cut flowers and foliage after hydrogen cyanide fumigation at different dosages for 30 min.

Commodity	Dosage (ppm)				
	0	2500	3700	4600	5500
Ginger					
Red	S[a]	S	C[b]	H[c]	H
Pink	S	S			
Heliconia					
Andromeda	S	S	S	S	
Lobster claw	S	S	S	-	H
Parrakeet	S	S	S	S	-
Parot	S	S	S	-	S
Sassy	S	S	S	-	S
Foliage					
Bamboo orchid	S	S	S	-	S
Calathea	S	S	S	-	S
Lycopodia	S	S	S	-	S
Peacock Ti	S	S	S	-	S
Anthurium					
Ozaki	S	S	S	H	-
Midori	S	S	S	S	-
Protea					
Pink mink	S	-	-	S	-
Orange banks	S	-	-	S	-
Yellow-green banks	S	-	-	S	-
Pink frost bank	S	S	S	S	-
Sunset	S	S	S	S	-
Sunrise pincushion	S	C	H	H	-
Scarlet ribbon	S	-	H	H	-
Hybrid 36	S	H	H	H	-
Hybrid "A"	S	-	C	H	-

[a] S - Safe, no significant damage compared to control.
[b] C - Caution, some may have significant damage compared to control.
[c] H - Harmful, significant damage compared to control.

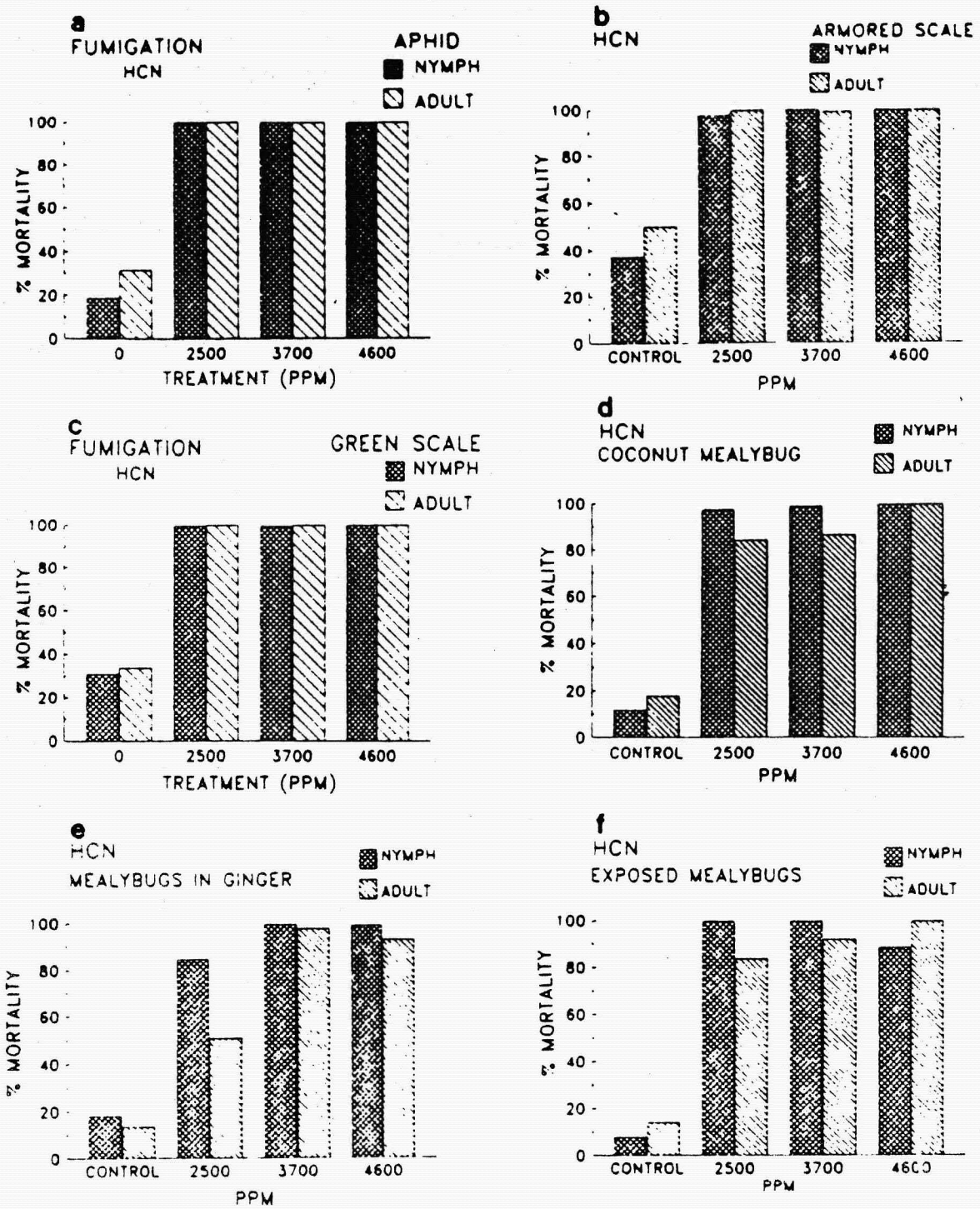

Figure 1. Efficacy of hydrogen cyanide fumigation of 30 min: a, banana aphids in ginger flowers; b, magnolia white scales on oleander leaves; c, green scales on ixora leaves; d, coconut mealybugs on palm leaves; e, mealybugs in ginger flowers; f, exposed mealybugs.

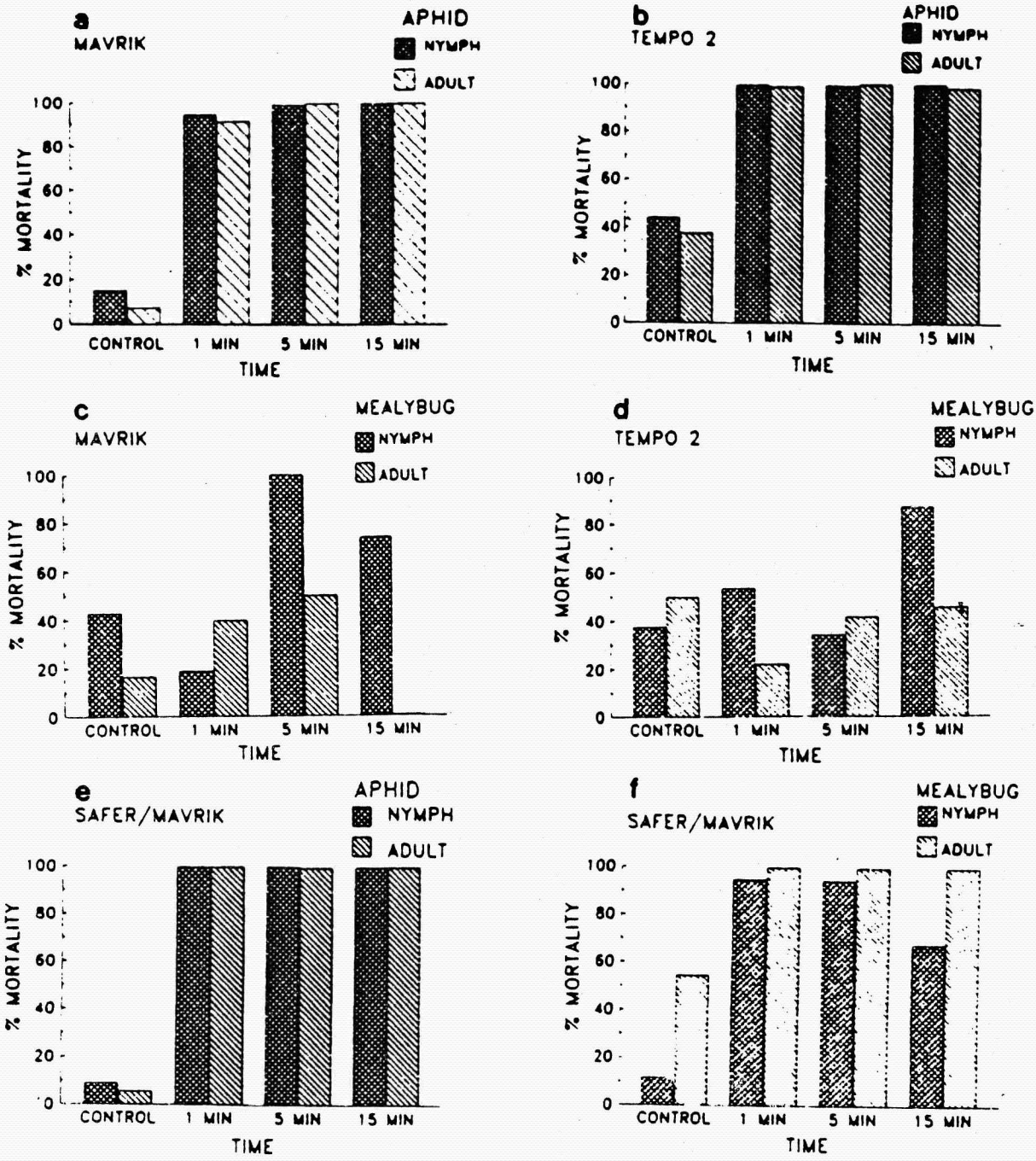

Figure 2. Efficacy of chemical dips against pests in red ginger: a, Mavrik with banana aphids; b, Tempo 2 with banana aphids; c, Mavrik with mealybugs; d, Tempo 2 with mealybugs; e, Safer Soap/Mavrik with banana aphids; f, Safer Soap/Mavrik with mealybugs.

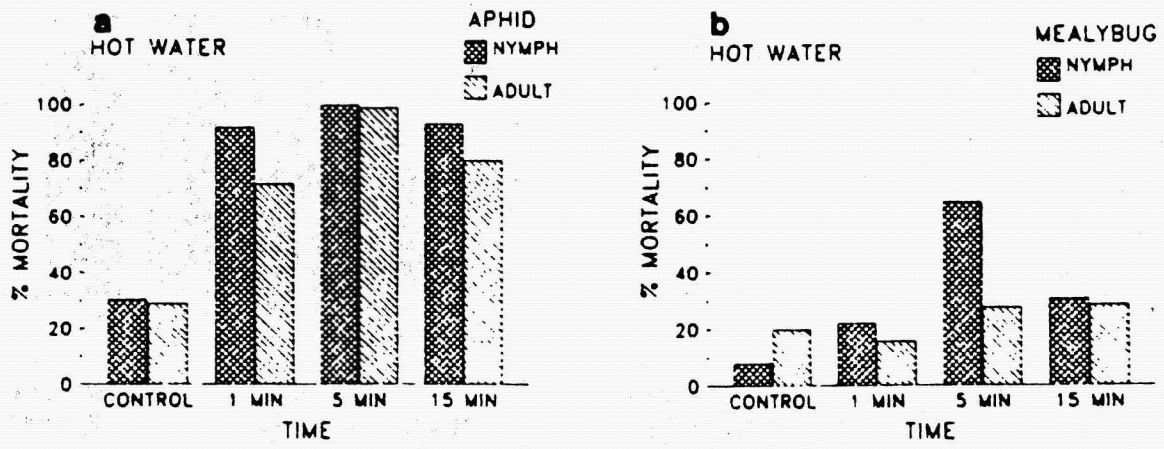

Figure 3. Efficacy of hot water (117^{0}F/47^{0}C) baths against insect pests in red ginger: a, banana aphids; b, mealybugs.

WHY EVERY PRODUCER SHOULD BE KNOWLEDGEABLE OF MARKETING

by
Charles H. Ingraham
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During this conference you have had the opportunity to learn from experts from around the world. From those who have already spoken to you during this outstanding conference, you should know that producers can use marketing to increase their income and thus increase their profit as well.

I have heard producers say, "I am a grower; I have all I can do producing and I have no time for marketing;" "I have someone else do my marketing;" "Marketing is not a problem for me as I can sell everything that I produce."

As a rule, growers who are not knowledgeable of marketing are not comfortable discussing or doing marketing and thus their operations are not as profitable as they could be.

Change has been the theme contained in the messages of those who have addressed you during this conference. I want to remind you of three ways that producers may react to change. There are those who create change, and thus their profit may increase. There are those producers who react to change or follow the lead of those who create change; thus they may not see much change in their profits. The third group are resisters to change. These producers do not change but continue to do as they always have and thus can expect to have less profit. I assume that most of you are creators of change or you would not have attended this outstanding conference.

Marketing means many different things to different people. To some farmers, marketing means only selling and getting paid for the products that they produce. To a homemaker, marketing may mean buying cut flowers at a store. However, selling and buying are only two parts of marketing.

Like the word "marketing," the word "production" often means different things to different people. To some, production may mean only planting and harvesting. This is like saying marketing is only buying and selling. Farmers understand that to produce a product such as cut flowers there are many necessary functions in addition to buying and selling, such as seed selection, seedbed preparation, transplanting, cultivation, disease and insect control, etc. Growers also recognize that if any one of these functions of production is ignored, there can be a crop failure. The same is true for marketing, as all the marketing functions need to be done in harmony.

Marketing is one of those words in our English language that not only means different things to different people, but it is also used in many different ways. My Webster Dictionary says, "marketing is the aggregate of functions involved in the transferring of ownership and in moving goods from producer to consumer

including, among other things, buying, selling, storing, transportation, standardizing, financing, risk bearing, and supplying market information."

Marketing includes all those functions involved in the moving of products from production to consumption. That is to say, getting the product from who and where it is produced, to where the consumer wants it, in the form it is wanted, and at the time it is wanted, so that it can be exchanged for dollars with the producer's share of those dollars being returned to the producer.

Marketing functions are usually grouped as to: buying, selling, transportation, packaging, standardizing, risk taking, financing, market information, storing, and advertising and promotion.

The marketing process is a two-way flow, moving cut flowers from grower to consumer and money and information about the consumers satisfaction back through the process to those who do the marketing functions and to the grower.

Producers need to be knowledgeable of marketing so that they may profit from the information that marketing provides. Marketing provides communication between the producer and consumer. Producers can learn what the consumer is willing to exchange his dollars for and thus plan his production accordingly.

Each of the marketing functions (buying, selling, transportation, standardization, packaging, market information, storage, risk taking, financing, advertising and promotion) adds value to the product produced by the grower. Those who perform each of the marketing functions are paid for their efforts. Growers may perform all or part of some marketing functions such as standardizing, packaging, transporting, financing, etc. They may standardize the product as to color, size etc. They may package the product. They may deliver the product to some point in the marketing channel. They may even do all the marketing functions and deliver their product directly to the consumer. The grower may do the market functions of risk taking and financing by accepting payment after the product is in the consumer's possession.

By being knowledgeable of marketing, producers may increase their profit by using market information as a guide to what and when and how much to plant. Those producers who are not "tuned in" to the market information function may continue to produce a product that the consumer is no longer willing to pay top dollar for, and thus the grower's operation may not generate a profit. Market information can also alert producers to opportunities to do certain marketing functions that can add value to the product produced while the product is still in their ownership, and thus increase their annual profit.

Accurate records of costs and income are as necessary in marketing as in profitable production. Not only must growers know what it costs to grow the various products, they must also know what the costs are for them to perform marketing functions. The producers' cost and income records must show that the value added for doing a marketing function will cover the cost of doing that marketing function, plus a profit.

Marketing functions will be performed by those who can do the task most efficiently. It may have been your idea, but business goes to the one that can do it the best and the cheapest.

The market information may be that the product was not fresh enough when it arrived or not in good condition. This tells the grower to examine the harvesting and post-harvesting practices, or perhaps consider producing a variety with longer shelf life or a variety that has better handling and shipping qualities. Maybe a more efficient method of transportation should be found. If the message does not reach the producer or is ignored by the producer, the consumers may decide to exchange their dollars for another product, and then the producer losses income and thus profit. All those who perform marketing functions will lose income. The message may not originate with the consumer but may come from any of those who do the marketing functions.

We often use the term "utility" as we explain what the marketing process does for a product such as cut flowers. Cut flowers in a bucket in a Hawaii grower's shade house are of no value to a consumer in Ohio, because they are not where the consumer can use them, and besides, the consumer may want only one or two red ones and in fact the consumer has no need for the rest of the cut flowers in the bucket. "Place Utility" is created by transporting the product to where the consumer wants it. "Time Utility" is having the product in the consumer's ownership when it is wanted. "Form Utility" is having the product in the form in which the consumer wants to use it. For example, while the bucket of cut flowers in the Hawaii grower's shade house has no utility for a consumer in Ohio, a design containing four or five cut flowers from the Hawaii grower's bucket combined with a dozen cut flowers produced in two or three other countries, in an attractive container (that cost more than the cut flowers), delivered to a mother the day before Mothers' Day, does have utility for the consumer. The grower's cut flowers that were in the bucket are exchanged for the consumers' dollars and the grower's payment is sent to him via the marketing system.

Group marketing is an alternative for those growers who may want to join together to do their marketing. By joining with other producers in a cooperative, growers can increase their income by having their cooperative performing marketing functions. The cooperative returns to the producer his share of the value added to the products as the result of the cooperative doing marketing functions. As a rule, successful marketing cooperatives require their members to enter a marketing agreement that requires the member to follow production practices established by the cooperative as well as deliver all of the product produced by the grower to the cooperative. The grower must also provide the necessary financing for the cooperative to function profitably.

Some growers may elect to be contract producers and thus not be bothered with marketing. As a rule, the contractor makes all the production and marketing decisions and the producer carries out the contractor's instructions as to what, when and how to produce and harvest. The contract producer is often paid a set salary or

rent and may receive an additional amount for meeting or exceeding certain production goals.

Hawaii growers need to recognize that other areas of the world have been developing marketing channels or institutions for many years. On the Mainland, for example, this has been going on for 200 years. Hawaii growers are playing "catch up." As we see in a ball game, there are some dangers in playing catch up, and one of those dangers is taking short cuts. Knowing and understanding marketing and the functions of marketing can be a valuable guide to Hawaii growers in avoiding costly mistakes.

Understanding of marketing can help the grower sort out the facts from the fiction. For example, I have heard some say that Mainland florists will pay a higher price for Hawaii products because they want to "buy American." Think about that; is that the way you purchase your inputs: buy American without regard for price? True, there are some consumers who, at times, will pay more for Hawaii cut flowers, but they tell me that the reason they pay more is because of quality, not "buy American."

Advertising is a part of the promotion function. Promotion is to stimulate consumer awareness of, and interest in, a product. Advertising has two objectives, first to expose a product to selected consumers and then to encourage those targeted consumers to buy the product. As with all the other marketing functions, promotion and advertising must be carried out in harmony with all the other marketing functions.

"Promotion programs are one of the most debated marketing issues in agriculture today. Whether they are worthwhile depends on who you talk to," according to Dr. Eugene Jones, Agricultural Economist at Ohio State University. More than 80 agriculture commodities have national promotion programs. Nationally, 90 percent of all commodity producers contribute about $560 million to promotion programs each year. Dr. Jones points out that promotion programs focus on changing consumers' attitudes toward a commodity by providing information about product characteristics (Milk Kick, Real Seal; Beef, real food for real people; Pork, the other white meat). Some of the problems with the promotion programs are the "free rider," and farmers can not see results at the farm level.

Promotion and advertising that are not carried out in harmony with the other marketing functions can work against those producers whom it is designed to benefit. If promotion and advertising are successful and create more demand than can be filled by those paying for the promotion, consumers will satisfy their wants by going to other producers of other products. For example, if Hawaii promotes tropical flowers and stimulates a demand that Hawaii producers cannot fill, then Central America growers may get the benefits and the business.

Product differentiation assists in capturing the benefits of promotion and advertising. You have all seen stickers on bananas and papayas that identify them and give them what we call product differentiation.

Marketing is also on the input side of production. The grower must purchase inputs such as labor, fertilizer, pesticides, etc. The same functions are present for the input marketing channel and the output marketing channel. The grower can perform certain of the marketing functions on the input side, such as transportation, storage, financing, etc. Here again, the value of accurate records is important for the grower to decide which of the marketing functions to do.

Growers also have responsibility in the function of market information. They need to inform the system of what to expect from their operation. They may find it profitable to inform the system of any changes in amount or kind of product they expect to have coming to market. They may let it be known that they expect to have a large supply of high quality reds in another week; as this information goes through the marketing channel, a demand may be created or information might be returned that the market channel is expected to be oversupplied with reds at that time. The grower must use this information to adjust the production program. Can harvest be at an earlier stage? Is there another market? With the use of cost records, it may be found to economic advantage not to send this product to market when there is an oversupply and thus not incur the additional expense.

Each of the speakers who have preceded me at this outstanding conference have presented many excellent suggestions and ideas. Now it is up to you! I challenge each of you to take one or more of the ideas or suggestions presented by each of the speakers and use them in your operation.

Growers who are knowledgeable of marketing and use that knowledge usually are the producers who increase their profit without increasing their production.

STATISTICS THAT SHAPE HAWAII'S FLORICULTURE INDUSTRY

by
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Statistics are useful for a variety of purposes. They are helpful to industry leaders and government agencies who plan and develop marketing strategies and programs. They assist prospective producers in making informed decisions about the growth potential and profit potential of crops and, similarly, they assist existing producers with their decisions to expand or scale back production of crops. Statistics are also useful to private and government funding agencies that must allocate scarce resources appropriately. Table 1 shows the wholesale value of various floriculture crops and research funds allocated from federal and state sources. Some appear to be over-funded. This may be the result of politics or it may be due to industry leaders effectively promoting their cause. Other crops appear to be under-funded. This is usually the case where a crop or crop group lacks a statewide organization through which it can voice its concerns.

Table 1. Research funds spent on floriculture research in Hawaii

	Value of sales (x 1,000) 1989	Percent of total sales	Sources of research funds (1985-1989, 5 yrs) (x 1,000) Federal	State	GACC	Total	Percent of total research funds
Anthurium	$ 7,811	23	$ 374	$ 697	$ 961	$ 2,032	45
Dendrobium	5,667	16	188	363	297	848	19
Other orchids	4,275	12	37	137	0	174	4
Tropicals	4,023	12	11	138	0	149	3
Carnation	1,660	5	2	78	159	239	5
Protea	1,184	3	26	503	159	688	15
Other flower	9,816	29	31	258	85	374	8
Total	34,436	100	669	2,174	1,661	4,504	100

This paper focuses on the four groups of floriculture crops that appear to have the greatest growth potential in export markets: tropicals, anthurium, protea, and orchids. The data analyzed in this paper has been taken from "Statistics of Hawaiian Agriculture--1989," a publication of the Hawaii Agricultural Statistics Service, Hawaii Department of Agriculture.

Table 2. Value of sales (thousands of dollars) of tropical flowers and foliages by county in 1989

	Hawaii	Kauai	Maui	Oahu	State
Gingers	453	90	613	421	1,577
Heliconia	384	102	362	282	1,130
Total	837	192	975	703	2,707
% of state	31%	7%	36%	26%	100%

Tropicals

Numbers of farms producing tropical flowers and foliages increased significantly between 1985 and 1989 (Figure 1). Noteworthy is the increased number of producers of gingers and heliconias; ginger producers grew from 65 to 121, and heliconia producers grew from 34 to 120.

As an industry, tropical flowers and foliages have shown a dramatic increase in total production acreage in recent years (Figure 2). Since 1986, the industry has increased its production acreage an average of 40 percent each year. Ginger has led the way with an increase from 66 acres in 1986 to 199 in 1989, an average annual increase of 46 percent. Heliconia followed closely with an increase from 69 to 194 acres, an annual average of 42 percent. Increases in production acreages of bird of paradise and cut foliages has been steady but less spectacular.

Units sold (dozens of stems) of bird of paradise, ginger, and heliconia increased an average of 44 percent each year between 1986 and 1989 (Figure 3). Ginger showed a linear increase from 78,000 units in 1985 to 280,000 in 1989 (average 39 percent per annum). Heliconia grew from 31,000 units in 1985 to 206,000 in 1988 and experienced a drop of 21 percent in units sold in 1989. Bird of paradise unit sales have increased an average of about 6 percent per year to 85,000 in 1989.

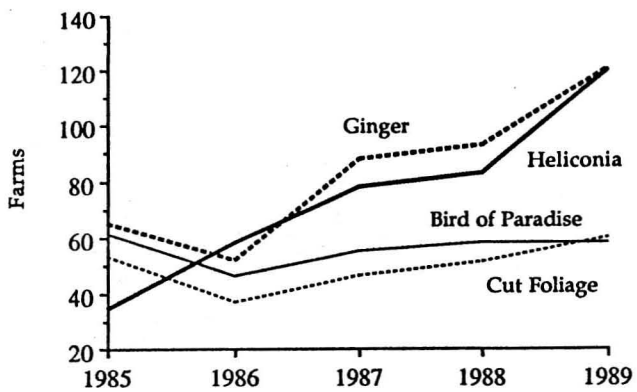

Figure 1. Numbers of farms (tropicals).

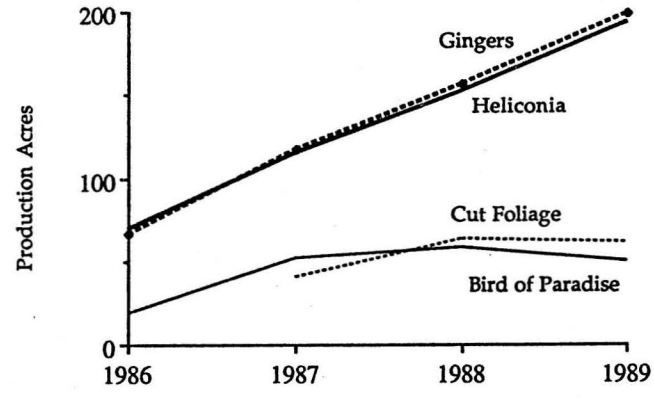

Figure 2. Acres in production (tropicals).

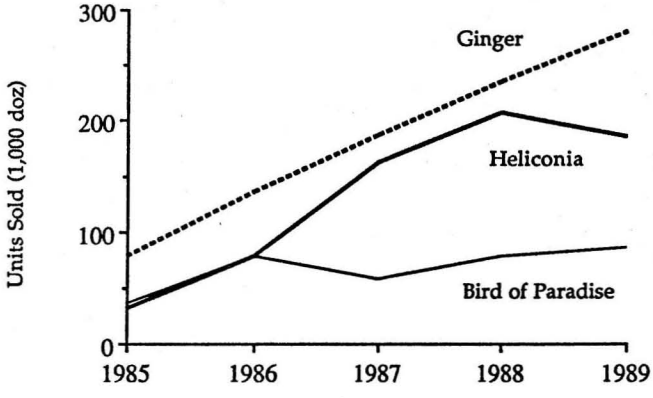

Figure 3. Units sold (tropicals).

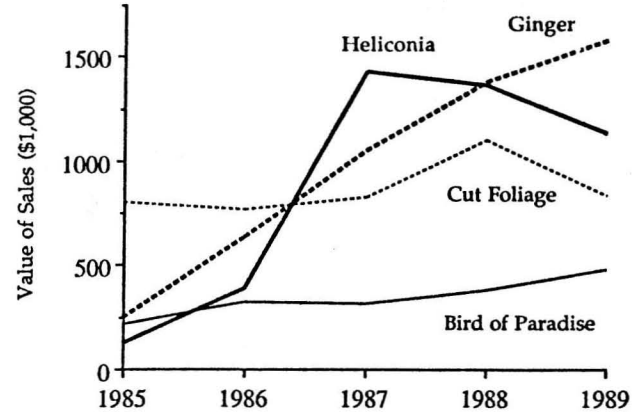

Figure 4. Value of sales (tropicals).

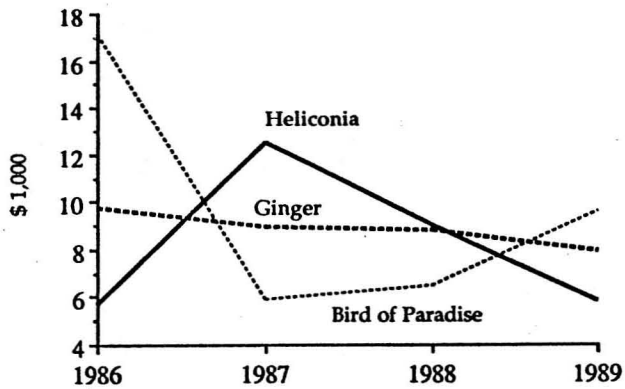

Figure 5. Revenues per acre (tropicals).

The tropicals industry experienced an average 27 percent increase in sales value since between 1985 and 1989 (Figure 4). Heliconia increased spectacularly from $125,000 in 1985 to $1,427,000 in 1987 but then had two years of declining sales to a low of $1,130,000 in 1989. Ginger showed a nearly linear growth in sales value from $246,000 in 1985 to $1,577,000 in 1989, an average annual increase of 67 percent. Bird of paradise sales value increased an average of 24 percent per year to $480,000 in 1989, while cut foliages increased by only 3 percent annually during the period to $836,000.

Average sales price per unit (dozen) for bird of paradise, ginger, and heliconia increased almost 7 percent in 1986 but thereafter averaged about 4 percent per year to 1989. Ginger experienced a price decline of 4 percent in that year, to $5.63 per dozen. Heliconia had two consecutive years of price decline, from $8.86 per dozen in 1987 to $6.11 in 1989. (The heliconia genus is the most diverse of the tropical flowers, having small, medium, and large types, with sales prices somewhat proportional to size. Data on all types of heliconia is pooled, and there is thus no differentiation by type. If market preference for type changes from one year to the next, this can skew the average pooled price to that type. Until data for *Heliconia psittacorum* cultivars is kept separately from other types, it will continue to be difficult to interpret pricing and revenue data for heliconias.) Sales prices of bird of paradise units have fluctuated from a five-year high of $6.09 in 1985 to a low of $4.17 in 1986; the 1989 price was $5.65.

Revenues per acre for tropical flowers have shown a decline (Figure 5). Production area increased far more rapidly than sales of units, value of total sales, or price per dozen. Heliconia revenues per acre declined from $12,500 in 1987 to $5,800 in 1989, while ginger revenues per acre declined an average of 6.5 percent per year between 1986 and 1989. As a group, tropical flowers experienced an average annual decline in revenues per acre of about 6 percent during that period. Although reference is made to gross return per acre, caution is advised as this is an average and does not reflect profitability, which must include costs.

Anthurium

Anthurium blight has been the most discouraging and frustrating problem ever experienced by most anthurium growers. This type of epiphytotic is not unusual in crop production. Agricultural history has many examples of grain, starch, pulse, spice, ornamental, nut, and forest crops that have been ravaged by specific diseases or pests. The blight disease, caused by *Xynthomonas campestris* pv. *dieffenbachiae* (Xcd), is widespread not only in Hawaii but throughout most of the world where anthurium is cultivated. It has been reported from American Samoa, Australia, Costa Rica, Fiji, Guatemala, Guadeloupe, Jamaica, Martinique, Philippines, South Africa, Taiwan, Thailand, and Trinidad. The disease is no doubt present in many other tropical areas. Hawaii's growers are fortunate that the state and federal governments have responded with more than adequate funding and that the University of Hawaii at Hilo and Manoa have responded promptly with research and extension programs that have already demonstrated how the disease can be effectively managed.

Prior to the widespread incidence of blight in Hawaii, anthurium cultivation was relatively simple and carefree. Little technology was required. Management was less stringent. Field sanitation was practiced rather casually. Life is different for the successful anthurium grower today. Research has demonstrated that high levels of sanitation and prevention are required if one is to be a successful producer. Plant pathology and horticulture researchers and specialists and agents have done an excellent job of educating the industry about this disease and other aspects of anthurium cultivation. Some have been quick and thorough in adopting the recommended sanitation and prevention measures. Some growers have applied levels of sanitation even more stringent than the recommended levels. Other growers have been slow to catch on or they have taken a wait-and-see attitude. Generally speaking, those who have practiced the highest levels of sanitation and prevention have had the best results in combating the disease. There are several examples of growers achieving a high level of success after initially disastrous experiences with blight. The farms of Floral Resources, Greenpoint, and Hawaiian Heart are three examples that can be viewed as role models. They grow the same blight-susceptible cultivars that are grown throughout the industry. They have no magic chemicals or biological agents. They simply practice high levels of sanitation and prevention.

The effect of anthurium blight on the industry and the effectiveness with which the industry has dealt with the disease are reflected by changes in the performance of the industry which can be measured and followed in part by the industry's output statistics.

Anthurium production acreage had declined from 451 in 1985 to 344 in 1989 (Figure 6), a 6.5 percent average annual decrease. Similarly, the number of farms producing anthurium has dropped from 195 in 1985 to 155 in 1989, a 5.5 percent average annual decrease. The average farm size at 2.2 acres in 1989 is only slightly smaller than the 2.3 acre average farm size in 1985 but significantly below the 2.6 acre size of farms in 1987.

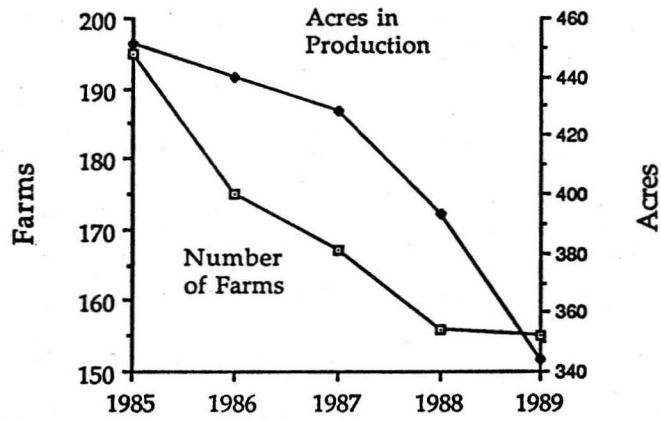

Figure 6. Number of farms and acres in production (anthurium).

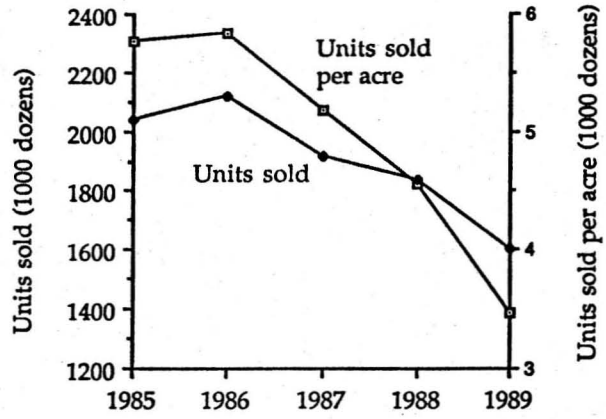

Figure 7. Units sold and units sold per acre (anthurium).

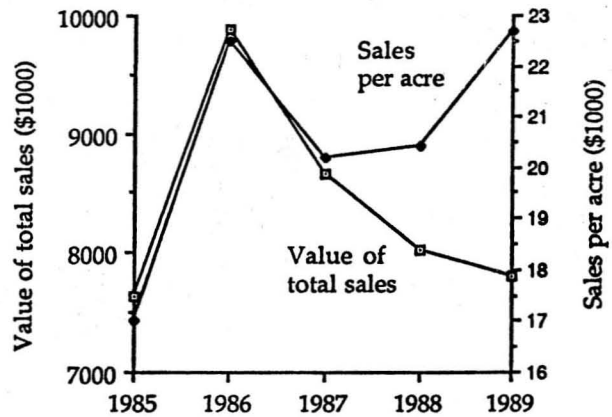

Figure 8. Value of total sales and sales per acre (anthurium).

Figure 7 illustrates the downward trend in total units sold by the industry and average units sold per acre. For the four-year period 1985 through 1989, total units sold and per-acre units sold were down by an average annual decrease of 11.5 percent and 5.7 percent, respectively.

The value of total sales and the revenues generated per acre from anthurium sales have been cushioned against the devastation caused by blight by significant increases in sales prices. 1989 revenues exceeded 1985 revenues despite steady decreases since 1986 (Figure 8). Revenues per acre have shown an 8.6 percent average annual increase from $17,000 per acre in 1985 to an all-time high of $22,700 per acre in 1989. This is the result of 14.9 percent average annual price increases from $3.32 per dozen in 1985 to $5.64 per dozen in 1989.

For the diligent grower who practices high levels of sanitation and prevention and suffers minimal losses to blight, these are exciting and lucrative times because of high prices and high demand. Anthurium blight has caused growers to become more professional and sophisticated in their production techniques and practices. The successful growers are paying closer attention than ever before to nutrition, pest control, spacing density, irrigation frequency and methods, sanitation, rogueing, security, and other production and business aspects. As time goes on the less professional, less committed, and under-capitalized growers will leave the industry, and those growers remaining will expand. When this transition period is over, the Hawaii anthurium industry will be more professional than ever before, will remain the world's leading producer, and will compete favorably with all other producing nations in the world anthurium market.

Protea

The number of farms producing protea has fluctuated between 18 and 42 during the period 1985 through 1989. The 36 producers in 1989, however, are only one more than the 35 in 1985 (Figure 9). Production acres, after falling from 125 in 1985 to 91 the following year, were at a high of 128 in 1989.

The number of stems sold has shown and average annual increase of 16.6 percent from 1985 to 1989 (Figure 10). Similarly, stems sold per acre have increased by 15.3 percent per year on the average. Growers offer several reasons for these increases, including improved marketing and promotions, a better mix of desirable cultivars over earlier years, and higher yields from more mature plantings.

The protea industry has enjoyed very significant revenue increases in recent years. The total value of sales has increased an average of 17.9 percent per year while sales per acre have increased comparably at 17.2 percent per year on the average (Figure 11). These revenue increases have been due more to increases in units sold per acre than to anything else, since production acreage has shown only a slight increase, and product prices have not increased at all in recent years.

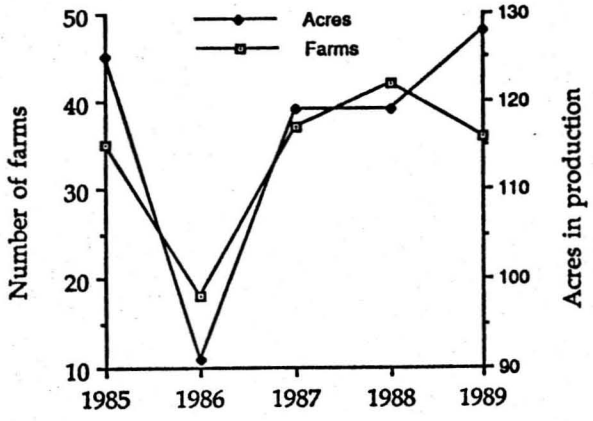

Figure 9. Number of farms and acres in production (protea).

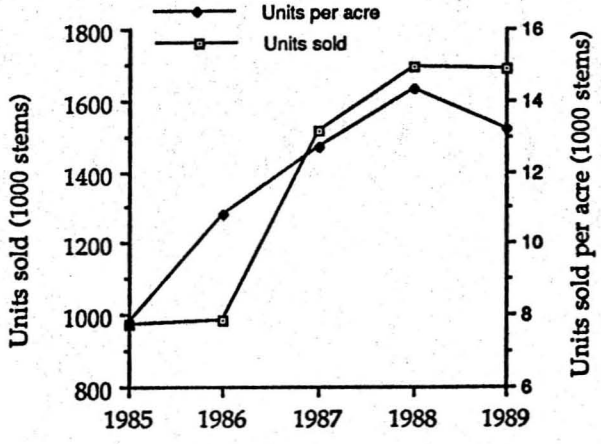

Figure 10. Units sold and units sold per acre (protea).

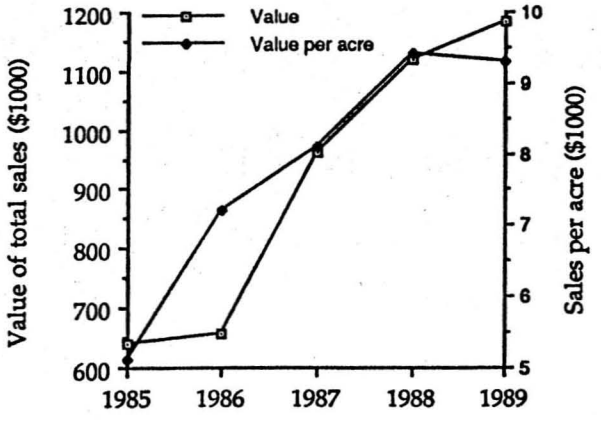

Figure 11. Value of total sales and sales per acre (protea).

Orchids

Orchids are the most important floral crop in Hawaii based on value of sales. The total wholesale value of orchids sold in 1989 was $9,942,000. Orchids are sold as cut sprays (dendrobium, oncidium), cut blossoms (cattleya, cymbidium), lei flowers (dendrobium, vanda), and potted plants (cattleya, dendrobium, phalaenopsis, vanda, and many other genera).

It is difficult to know exactly how many orchid growers there are. The statistics used in this paper have been provided by the Crop Reporting Service of the Hawaii Department of Agriculture (DOA). The DOA determines the number of "farms having sales" of various genera and whether they are potted or cut. A dendrobium grower therefore could be recorded as three "farms having sales" if he produced and sold potted plants, lei flowers, and cut sprays.

There are no fewer than 83 dendrobium producers, since this is the recorded number of sellers of cut sprays for the years 1988 and 1989. There are 53 recorded sellers of dendrobium lei flowers; these, however, are almost certainly included among the 83 sellers of cut sprays. We do not know of a single grower who produces dendrobium exclusively for the lei flower trade. There were 80 producers of dendrobium potted plants in 1989. Some of these would be included as sellers of cut sprays, but many are strictly producers of potted plants. Some may also be producers of other genera of potted orchids and be included in the "other potted orchids" category, which numbered 67 in 1989. Figure 12 shows how the numbers of producers of various orchid products have fluctuated in recent years.

Dendrobium is the most extensively cultivated orchid in Hawaii, accounting for 75 percent of the total acreage in orchids. There were 68.3 acres allocated to dendrobium spray production and 21.8 acres allocated to production of potted dendrobium. In 1989 the acreage in dendrobium for cut sprays expanded by 17.5 percent over the previous year. Acreage in orchids has expanded by an average annual increase of 6.4 percent since 1986 to 120 acres in 1989, the all-time high (Figure 13).

The units sold of dendrobium sprays has gone up modestly but steadily each year since 1985 to 435,000 dozen in 1989, a 10.7 percent average annual increase during that period. Potted orchids (dendrobium and others) have shown the most significant growth in terms of units sold, averaging a 42.7 percent annual increase since 1985. The figures are skewed somewhat by an unexpected bumper year in 1987 to 1,756,000 pots, over 300 percent of the previous year (Figure 14). Some of this was young dendrobium plants sold to local cut flower producers and is reflected in expanded acreage of dendrobium cut spray production during 1988 and 1989 (Figure 13). The sale of individual blossoms for lei flowers increased to 59.6 million blooms in 1989, a 17.1 percent increase over the previous year and an average annual increase of 9.7 percent since 1985. The important orchid lei flowers are vanda (34.7 million blooms) and dendrobium (24.9 million blooms) (Figure 14).

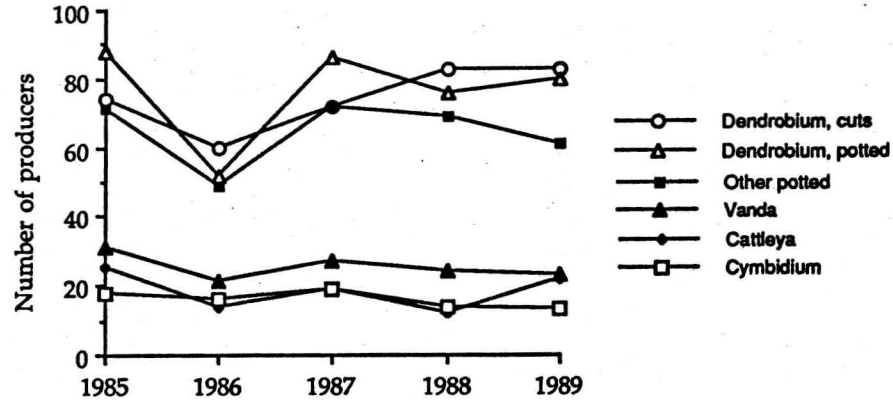

Figure 12. Number of producers (orchids).

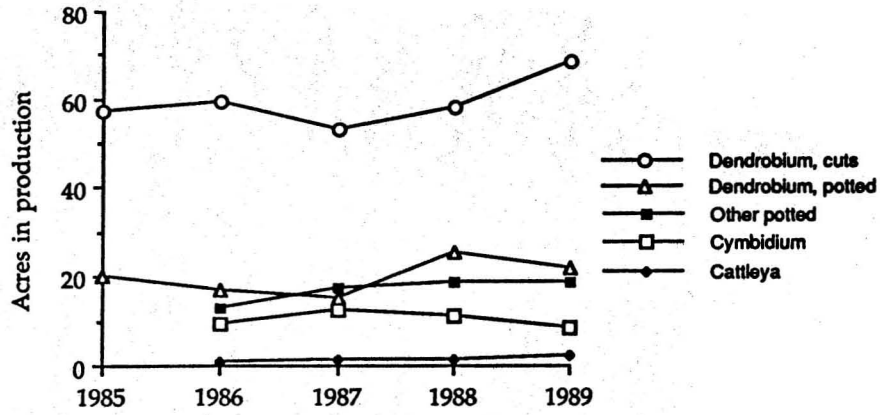

Figure 13. Acres in production (orchids).

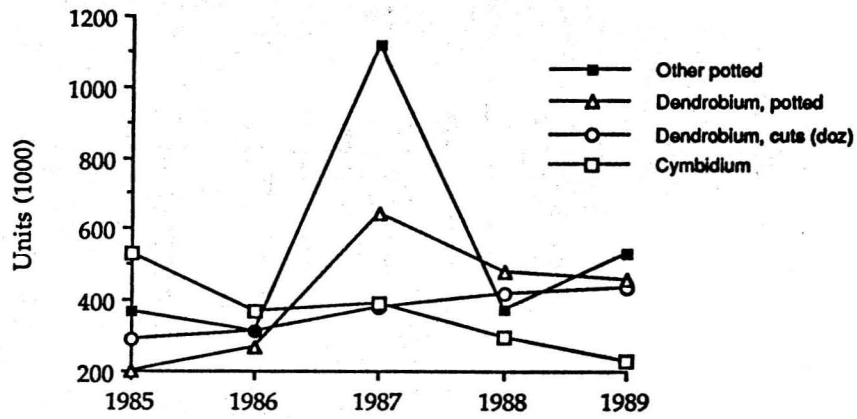

Figure 14. Units sold (orchids).

Units sold per acre is intended to allow producers to compare their productivity with industry-wide averages and to show prospective producers what realistic expectations of crop productivity are. The data, however, are not easily interpreted, as they are influenced by seasonal weather conditions, pest and disease outbreaks, industry expansion (nonbearing acreage), crop maturity, foreign competition as well as state, national, and world economies. Producers of dendrobium sprays appeared to have an average year at 6,400 dozen sprays per acre. During the period 1985 through 1989 the range was 5,100-7,200 dozen sprays per acre (Figure 15). Potted dendrobium growers enjoyed a bumper year in 1987 when the average was 41,600 pots sold per acre. There has not been a year nearly that good before or since. The two years prior to that were below average, which may have contributed to an inventory buildup that made such a big year possible in 1987. A prospective producer should not make the mistake of projecting to sell 40,000 pots per acre per year simply because it had been accomplished in one year. Even this figure requires a disclaimer, since there is no good data on pot sizes used; however, it is assumed that the majority are 2- to 4-inch pots. Other potted orchids similarly enjoyed a bumper year in 1987 with the sale of 64,100 pots per acre. The data is interesting for comparative purposes but is of questionable value because a large number of genera and pot sizes may be involved (Figure 15).

The value of sales for most orchid genera have increased impressively during the period 1985 through 1989. Cymbidium cut blossoms and vanda lei flowers are the only two that have declined. Dendrobium has shown an average annual increase of 13.7 percent for cut sprays and 24.4 percent for potted plants (figure 16). The average annual increase in value of sales of other spray orchids and other potted orchids has been 10.0 percent and 9.9 percent. Collectively (all genera, cut and potted) the value of orchid sales was $9,942,000 in 1989, which represents a 15.8 percent increase over the previous year and an aveage annual increase of 10.2 percent since 1985.

The highest revenues per acre are recorded for other potted orchids at $168,600 per acre in 1989 and an average of $144,700 per acre since 1986. Potted dendrobium recorded a single-year high of $143,400 per acre in 1987 and has averaged $97,500 per acre since 1986. Cut orchids register much lower figures with dendrobium, cattleya, and cymbidium showing average revenues per acre of $41,600, $31,200, and $15,600, respectively, for the period 1986 through 1989. Figure 17 plots the data for each year for selected potted and cut orchids.

The strongest increases in wholesale prices were shown by cymbidium, which has averaged a 17.3 percent increase per year to $0.59 per blossom in 1989. Dendrobium sprays have increased a modest 3.0 percent per year to $6.43 per dozen, while dendrobium lei blossoms have increased by the same 3.0 percent average per year to $0.028 each in 1989. Reductions were experienced by cattleya from $1.22 in 1985 to $0.88 in 1989, an average annual decrease of 13.1 percent. Similarly, vanda lei flowers have fallen in price from $0.042 in 1985 to $0.024 in 1989, an average annual decrease of 12.8 percent.

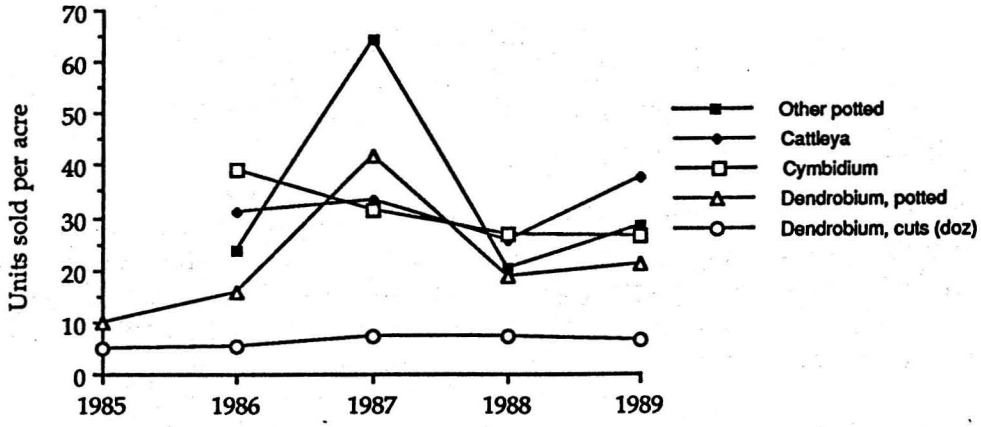

Figure 15. Units sold per acre (orchids).

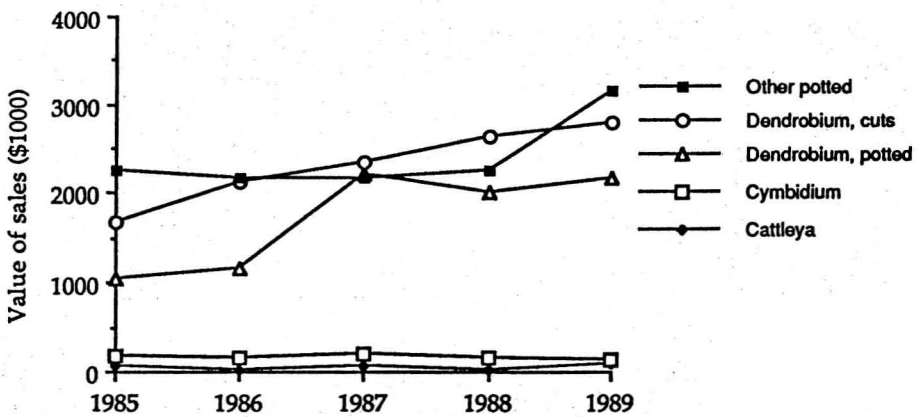

Figure 16. Value of sales (orchids).

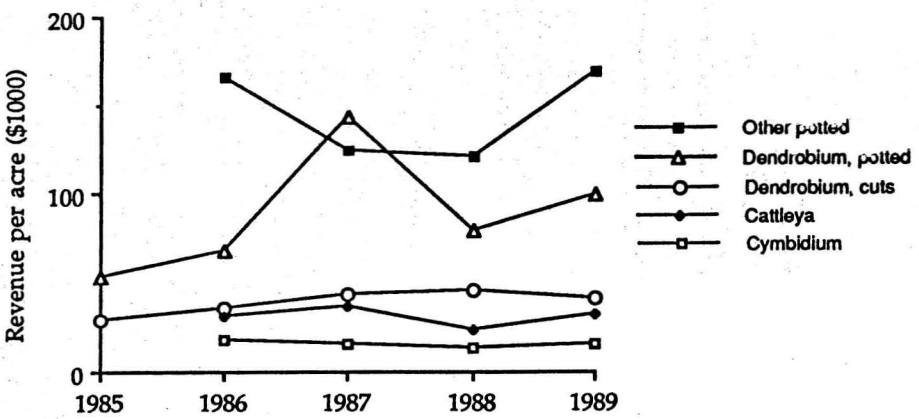

Figure 17. Revenues per acre (orchids).

HOW THEY GROW AND MARKET ANTHURIUM IN THE NETHERLANDS

by
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Anthurium is grown in the Netherlands as a cut flower and a pot plant. In this short lecture I will only deal with Anthurium as a cut flower. Anthurium is a very special cut flower and differs enormously in growing technique, climate, and the flower itself from, for instance, a tulip, the symbol of Holland. Anthurium as a very special flower is an indispensable part of our total assortment.

The area of anthurium in the Netherlands has changed a lot over time. In the seventies the area in use for Anthurium was much bigger.

Area of anthurium in the Netherlands (glasshouses)

Year	Ha	Acres
1975	75	187
1980	65	162
1985	59	147
1987	64	160
1989	53	132

At the moment, the area is more or less stabilized. The area is now 30-40 percent smaller than in 1975, but the production in number of stems delivered at the auction is not lower, as shown in the next table.

Supply of anthurium at the auctions

Year	Number of stems (millions)
1975	15
1980	17
1985	16
1987	15
1989	17

That means that the productivity per unit area is much higher now than ten years ago. Also, the average price at the auctions is now higher than fifteen years ago. That is a result of a better quality flower and a more attractive assortment.

How is the assortment composed? Of course, orange is still the most important color, together with red, but more and more other colors such as pink, white, and others are becoming more important, and even leaves are sold. Some of the main varieties in the Netherlands are:

Variety	Millions of stems
Avonette (orange)	3.4
Tropical (red)	2.5
Oranje Favoriet (orange)	1.2
Cuba (white)	1.1
Avoanneke (pink)	0.8
Others (more than 50)	7.4

Most of the flowers we produce in the Netherlands are produced year round, but that does not mean that the production is constant throughout the year.

Also with anthurium, we see a real influence of the winter lower light intensity on production. In the following table you see the production in millions of stems during the year.

Month	Number of stems (in millions)
January	1.0
February	0.9
March	0.8
April	1.0
May	1.9
June	1.8
July	1.7
August	1.8
September	1.7
October	1.8
November	1.4
December	1.4

So the peak of production lies in the late spring and summer months. First, leaves have to be formed. The number of flowers is very closely related to the number of leaves.

The propagation of anthurium is only by tissue culture at the moment. That gives the possibility to propagate good selections and clones. That is very important, for tissue culture does not bring a better variety; breeding and selection has to do that.

As a growing medium for anthurium, several substrates are used: pine needle soil, course peat, rockwool, and foam. All are expensive, but more and more interest is seen for foam as a substrate. We expect that with recirculation of the liquid nutrient a so-called closed system can be developed. That will be desireable in the future, from the point of view of the environment. Water quality is also an essential factor in the growth of anthurium. Rainwater is used in The Netherlands.

Climate control is of great importance both in winter and summer, requiring heating in winter, shading and ventilation in summer. The regulation system is computerized. Carbon dioxide enrichment is a normal practice in the Dutch horticultural production; mostly, the exhaust gases of the boiler are used. It is also possible to use a separate CO_2 boiler.

The cutting stage is important to have a good vase life for the flowers. The spadix must be ripe enough, otherwise the vase life is too short. The flowers are already selected in the greenhouse. Small flowers, and damaged flowers are separated immediately. Then flowers are packed in cardboard boxes and sealed at the bottom. The box is lined with plastic foam for protection against damage. Every flower is put in a plastic tube with clean water. That makes the transport independent of water supply from outside. Then the boxes are ready to transport them to the auction market.

Pests and Diseases

Thrips can be a problem and must be detected in an early stage by insect traps (yellow color with a glue on it). Nematodes can be a problem (*Rodopholus similis*). Temik (aldicarp) 600-900 g/100 m^2 gives good control, repeated after four weeks.

Bacterial disease is fortunately not a problem for the Dutch anthurium grower. Three quarters of our production of anthurium is exported. The main export country is West Germany. Second is Italy, with France in third place.

To summarize: anthurium is a very special flower in the Dutch assortment. The production area in the last ten years is rather constant. The newer varieties have a higher production and a better vase life. Besides the main colors orange and red, colors like pink and white have become more and more popular. The anthurium is a very constant and valuable crop in the Dutch assortment, but you have to treat it with care. When you can invest the money in plant material and substrate, it is a crop with reasonable profitability.

PLANT NUTRITION AND VASCULAR DISEASE

by
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Introduction

Bacterial blight of anthuriums caused by *Xanthomonas campestris* pv. *dieffenbachiae* is a vascular disease. That is, the bacteria live in the xylem of the host plant and from there induce symptoms of wilting and necrosis. This review, then, will center on vascular diseases and their relationship to plant nutrition with possible applications to bacterial blight of anthuriums. Fungal vascular diseases will be included, because both fungal and bacterial vascular diseases live and grow in the xylem on the materials available in the xylem sap. Thus, plant nutrition studies related to material in the xylem sap would apply to both bacterial and fungal vascular pathogens. The nutritional control of material in the xylem sap is most applicable in the early infection stages. After the pathogens fill the xylem and marginal necrosis begins, the pathogens are able to break down cell walls and cytoplasm and obtain nutrition from sources other than the xylem sap. We must also be reminded that most of the nutritional studies on vascular fungal pathogens are concerned with the soil-root environment because, unlike anthurium bacterial blight, these fungal pathogens are soil-borne. Bacteria and fungi, also, differ in their requirements for growth. The media for culture of anthuriums is not soil, but an artificial media: black cinders. Therefore, further studies must be made under Hawaii conditions before the research results reported in this review can be culturally applied to anthuriums.

Micronutrients

Deficiencies of some micronutrients are reported to increase vascular diseases. If silicon, which is required for support in grasses, is deficient in rice, there is an increase in susceptibility to bacterial blight caused by *Xanthomonas campestris* pv. *oryzae* (Tagami 1968). Although silicon is not a required nutrient element for growth of dicotyledons, silicon amendments to soil are reported to lower the incidence of *Fusarium* wilt in cucumber (Miyake and Takahashi 1983).

Deficiency of boron has been reported to increase development of *Fusarium* wilt on flax (Keane and Sackston 1970). In tomatoes, boron interacted with calcium. At 100 ppm of calcium, higher levels of boron decreased the incidence of *Fusarium*, while at 500 ppm Ca, higher levels of boron increased the development of the disease (Edington and Walker 1958).

Addition of iron to soils, to relieve deficiency, has also been reported to decrease the effects of *Verticillium* wilt. Higher levels of iron caused a dramatic recovery of mango from *Verticillium albo-atrum* in Florida and a great improvement of the health of peanuts affected by *V. dahliae* in Israel.

In the case of *Fusarium* diseases, care must be taken to apply only the amount of micronutrient required for optimum growth of the crop plant. *Fusarium oxysporum* f. sp. *lycopersici* has a relative high requirement for micronutrients, and concentrations of manganese, iron, and zinc as normally found in the soil solution for tomato culture are deficient for growth of *Fusarium*. Thus, there is a very dramatic increase in growth and sporulation of the fungus when higher concentrations of these micronutrients are present in culture media. Reduced concentrations inhibited growth and sporulation. Deficiency of copper and molybdenum in the fungal culture media also reduced growth and sporulation. Complete elimination of molybdenum and zinc reduced the virulence of the *Fusarium* (Jones and Woltz 1970, 1981; Woltz and Jones 1968, 1973b, 1981; Engelhard, Jones, and Woltz 1989).

In tomatoes, zinc has been found to induce toxin production by *Fusarium oxysporum* f. sp. *lycopersici* (Woltz and Jones 1971). Also, application of zinc as a lignosulfonate increased the percentage of wilt-diseased tomato plants (Jones and Woltz 1970). In *F. oxysporum* f. sp. *udum*, the fungus involved in wilt of *Cajanus cajan*, addition of zinc to the culture medium increased the production of fusaric acid (Prasad and Chaudhury 1974). Fusaric acid is a toxin that does not cause wilting, but which may play a secondary role in disease development (Kuo and Scheffer 1964).

Other workers have recommended managing the availability of iron to control *Fusarium* (Scher and Baker 1982; Simeoni, Lindsay, and Baker 1987; Yuen and Schroth 1982; Lemanceau 1989). These workers reported that bacteria compete with fungal cells by producing siderophores that complex (chelate) the iron ion and reduce the amount of iron available to the fungus. Thus, soils in the Salinas Valley in California that are known to suppress the occurrence of *Fusarium* disease have been shown to have large populations of the fluorescent *Pseudomonas* bacteria, which produce siderophores. However, addition of iron to the soil, in the form of FeEDTA (iron ethylenediaminetetraacetic acid), overcomes the iron deficiency and increases growth of the fungus, with an increase in *Fusarium* wilted plants in both suppressive and conductive soils. Addition of EDDHA (ethylenediaminedi-o-hydroxyphenly-acetic acid), a chelator which has a high affinity for iron, apparently makes the iron unavailable to the fungus and thus reduces its growth and decreases the number of *Fusarium*-wilted plants in both suppressive and conductive soils. The EDDHA has such a high affinity for iron that the fungus can not extract it. Thus, addition of FeEDDHA to suppressive soils also reduces the *Fusarium* wilt (Lemanceau 1989). Of interest is that the iron in FeEDDHA is available to the plants (Norvell 1972). These workers are thus in agreement in recommending that iron levels be kept at the minimum level for growth of the crop plant to obtain maximum control of the *Fusarium*.

The work on "Kresek" bacteria blight of rice, caused by *Xanthomonas campestris* pv. *oryzae*, is similar to the work on *Fusarium* in that zinc deficiency in rice increases the incidence of blight. However, it differs in that higher levels of zinc are recommended to create toxicity levels for the bacteria (Mew, Vera Cruz, Reyes, and

Zaragoza 1979). When roots of seedlings were dipped in 2.5 percent zinc sulfate or 2.0 percent zinc oxide and transplanted into the field, the disease disappeared. The zinc sulfate treatment was highly effective in the field in controlling the disease under natural conditions and also when the plants were artificially inoculated with the bacteria. Measurement of the population levels of the bacteria in the water from the zinc treated, and control plots showed a decreased population with zinc treatment. Also, growth of the *Xanthomonas campestris* pv. *oryzae* in vitro was inhibited by concentrations of 0.625 1.25, and 2.5 percent zinc sulfate.

Sulfur, Magnesium, Calcium, and Soil pH

Addition of sulfur as calcium sulfate to *Fusarium*-infested soil did not reduce the occurrence of tomato *Fusarium* wilt (Jones and Woltz 1969). However, calcium sulfate protected sodium and magnesium chloride stressed tomatoes from *Fusarium oxysporum* f. sp. *lycopersici*. The protection afforded by calcium sulfate, however, was attributed to the calcium ions which replaced the sodium and magnesium ions, of the polyglacturonic chains of the cell wall. Calcium nitrate also protected the stressed tomatoes from the *Fusarium* (Davet, Messiaen, and Rieuf 1966).

Magnesium is an essential element for growth of *Fusarium*, and if present in high amounts magnesium increases the incidence of tomato wilt. At higher pH values, magnesium is less available. However, addition of magnesium in amounts higher than that needed for plant growth increases the growth, sporulation, and virulence of *Fusarium* (Woltz and Jones 1981). When tomatoes were watered with magnesium chloride or sodium chloride solutions, severe wilt symptoms were produced in fields infested with a cool-temperature strain of *Fusarium oxysporum* f. sp. *lycopersici* (Davet, Messiaen, and Rief 1966).

As early as 1913, it was known that addition of large amounts of lime to the soil hindered the development of *Fusarium* wilt of tomatoes (Edgerton and Moreland 1913). Since that time, numerous other workers have associated higher pH and calcium with less *Fusarium* wilt in aster, carnation, chrysanthemum, cotton, cucumber, flax, gladiolus, muskmelon, radish, strawberry, tomato, and watermelon (see review in Engelhard, Jones, and Woltz 1989). The work on tomato showed that liming sandy soils to pH 6.5 to 7.5 greatly decreased the incidence and severity of *Fusarium* wilt and this is now the recommended cultural practice for growing tomatoes in *Fusarium* wilt infested soils.

Three explanations have been made for the effect of high soil pH in controlling *Fusarium* wilt. The first is that it is the high calcium content of the tissues of plants grown in high pH soils that induces resistance against many diseases (Vidhyasekaran 1988). Calcium in the host cell wall appears to make them more resistant to the penetration of pathogens (Palti 1981), and resistant tissues have been shown to have a higher content of water-insoluble calcium and pectin than susceptible tissues (Thomas 1966). Calcium apparently interferes with the breakdown of the cell walls by reacting with the free carboxyl groups formed by the action of pectin-methylesterase on the pectin chains during the infection process. The calcium reacts to form rigid cross connections between the pectin chains. This makes the

pectins more resistant to the action of polygalacturonases produced by the pathogen (Bateman 1964). The presence of these calcium pectates reduces the activity of the hemicellulose-degrading enzymes and the cellulose-degrading enzymes which appear later in the disease process. Growth of the vascular pathogen in the xylem is thus reduced because of the decrease in carbohydrates available to the pathogen due to the non-breakdown of the host cell wall.

Calcium is also essential for maintenance of membrane integrity. Host cell death during the infection process may be related to the extraction of calcium from the membrane during pectin enzyme breakdown of the cell wall. The presence of high levels of calcium would thus prevent the loss of membrane integrity and host cell death. Various proteins, amino compounds, lipids, and other substances would then not be available to the pathogen. In pepper, calcium is reported to retard the deterioration of the cell membrane (Sasser, Stall, and Cook 1968), and application of 0.2 N calcium nitrate suppressed the electrolyte loss from pepper leaves inoculated with race 2 of *Xanthomonas vesicatoria* (Cook and Stall 1971).

The second explanation for the reduction in incidence of *Fusarium* in high-pH soils is the lower availability of micronutrients. As discussed in the section on micronutrients, *Fusarium* has a high micronutrient requirement, and the disease can be controlled by reducing the level of micronutrients in the soil solution. This second explanation is supported by the fact that plants grown in high-pH soils are attacked by *Fusarium* if they are given zinc and manganese or iron and manganese in lignosulfonate complexes. The zinc, manganese, and iron in these complexes is available to the *Fusarium* even in the high-pH soils (Jones and Woltz 1970). Also, amendment of *Fusarium*-infested soils with calcium sulfate (gypsum) to bring calcium in the plant tissues to a high level did not change the soil pH and did not reduce the incidence of *Fusarium* infection of the tomatoes. In an identical plot amended with hydrated lime, the level of calcium in the plant tissue was equal to that of the gypsum-amended plot, but the pH was increased and the level of *Fusarium* infection was reduced (Jones and Woltz 1968, 1969).

The third explanation for the reduction of *Fusarium* in high-pH soils is the effect on the soil microflora. Actinomycete and bacteria populations are favoured in the soil by high pH levels (Waksman 1927). These micro-organisms may simply compete with the *Fusarium* for nutrients in the soil solution or they may actually secrete toxins that would inhibit growth of the fungus (Engelhard, Jones, and Woltz 1989). The fluorescent *Pseudomonas* bacteria in some soils also produce siderophores which chelate the micronutrients in the soil and make them unavailable to the *Fusarium* (Lemanceau 1989).

Phosphorus and Potassium

Phosphorus levels in excess of those required for optimal plant growth appear to increase the incidence of *Fusarium* wilt of tomato in both pot and field. Phosphorus amendments also increased the severity of *Fusarium* wilt of muskmelon (Sagdullaev and Berezhnova 1974). The availability of the phosphorus is decreased at higher pH values. Thus, increased phosphorus application to soils of pH 6.0 increase the

incidence of tomato wilt. However, increased phosphorus application to soils of pH 7.0 or 7.5 have no effect on the incidence of tomato "wilt", because the phosphorus is less available. The recommended cultural practice for control of *Fusarium* is thus high soil pH and low phosphorus fertilizers (Woltz and Jones 1973a, b, c; 1981).

In general increased amounts of potassium reduce the severity of the vascular diseases. In greenhouse experiments *Fusarium* wilt of tomato was more severe when potassium was deficient than when potassium was in a balanced solution (Foster and Walker 1947; Kendrick and Walker 1948). High nitrogen and low potassium favored disease development (Walker and Foster 1946). Ample supply of potassium has also been reported to reduce the severity of cotton wilt caused by *Fusarium oxysporum* f. sp. *vasinfectum* (Tharp and Wadleigh 1939; Black 1968), melon wilt caused by *Fusarium oxysporum* f. sp. *melonis* (Ramasamy and Prasad 1975; Perrenoud 1977), and wilt of oil palms caused by *Fusarium oxysporum* var. *albedinis* (Turner 1970). In *Fusarium* yellows of celery, an interaction with chloride was reported. Ratios of 3.5:1 for potassium: chloride disease was least, while at ratios above or below 3.5:1 disease was more severe (Schneider 1985). In brinjal plants potassium application reduced ascorbic content of the leaves and decreased *Verticillium* wilt incidence (Sivaprakasam, Soumini Rajagopalan, and Vidhyasekaran 1974).

Bacterial vascular pathogens also appear to be affected by increased potassium levels. Ample potassium supply reduced the severity of bacterial blight of rice caused by *Xanthomonas campestris* pv. *oryzae* (Tagami 1968) and bacterial wilt of cassava caused by *Xanthomonas manihotis* (Adeniji and Obigbesan 1976).

Nitrogen: Nitrate and Ammonium Forms

The most pronounced effect of nitrogen is on the vigor and rate of growth of the crop; both of these factors affect the degree of resistance or susceptibility of crops to pathogens (Palti 1981). Leaves of plants fertilized with excess nitrogen have loose tissues, with large thin-walled cells, ample intercellular spaces, and wide-open stomata, all features that facilitate development of disease (Grossmann 1970).

Huber and Watson (1974) have reviewed the literature concerning nitrogen form and plant disease. In general, *Verticillium* vascular diseases are more severe with nitrate fertilizers and less severe with ammonium fertilizers. Thus, *Verticillium* wilt of potato (Huber 1966), hops (Keyworth and Hewitt 1948), cotton (Ranney 1962), and tomato (Walker, Gallegly, Bloom and Shepherd 1954) all increase in severity with nitrate fertilizers. The explanation of the nitrate effect is in how the *Verticillium* disease develops in the crop plant in relation to maturity. In potatoes *Verticillium* infects the plant early and spreads throughout the plant early in the season. However, the disease does not manifest itself until vegetative growth slows and the plant reaches maturity. Thus, ammonium fertilizers, which delay plant maturity, delay the onset and the severity of the *Verticillium* disease. Nitrate fertilizers, in contrast, hasten the maturity of the plant and cause earlier manifestation and increased severity of the *Verticillium* disease (see review in Huber and Watson 1974).

Fusarium-caused vascular diseases are more severe with ammonium fertilizers and are controlled by use of nitrate fertilizers. Work on tomato clearly demonstrated that the disease severity decreased with increasing amounts of nitrate and lesser amounts of ammonium (Fisher 1935). Later researchers developed a cultural practice which involved the use of nitrate fertilizers to control *Fusarium* on several crops including cotton (Albert 1946), tomato (Jones and Woltz 1967, 1968, 1969, 1970, 1972, 1975; Woltz and Jones 1972, 1973a, b, c), chrysanthemum (Engelhard and Woltz 1972, 1973, 1978; Woltz and Engelhard 1978; Locke, Marois, and Papavizas 1985; Raju 1983), watermelons (Jones and Woltz 1975), cucumbers (Jones and Woltz 1975), muskmelon (Stoddard 1947), celery (Schneider 1985), radish (Schneider 1985), aster (Engelhard 1975; Engelhard and Woltz 1978), and carnation (Engelhard 1979).

Erwinia stewardii, the bacterial wilt of corn, is greatly influenced by the form of nitrogen. Like the bacterial blight bacteria of anthuriums, the corn wilt bacteria is confined to the xylem and cannot use nitrate ion as a source of nitrogen. Nitrate fertilizers thus reduce the incidence of the bacterial wilt. Addition of ammonium ion to tracheal exudates low in nitrogen resulted in heavy growth of the bacteria. Increasing nitrogen levels in the soil, which increases the nutrients in the xylem sap, also resulted in more growth of the bacteria and greater wilting (McNew and Spencer 1939). Potassium deficiency, which increases the uptake of ammonium ion, also increased the severity of the disease (Shear and Wingard 1944).

Possible Applications To Anthuriums

Mironutrients

Studies must be undertaken to determine the effects of the micronutrients on growth and virulence of *Xanthomonas campestris* pv. *diffenbachiae*.

The use of toxicity of zinc for control of blight of rice may to be applicable to anthurium. This is because the bacterial pathogen of rice, *Xanthomonas campestris* pv. *oryzae*, is closely related to the anthurium bacterial blight pathogen, *Xanthomonas campestris* pv. *diffenbachiae*. The infection court of the bacterial blight of rice also appears to be the hydathodes (Lee, Zhang, and Li 1979; Nakagami, Tanaka, Yamaoka, and Tsujino 1980; Guo and Leach 1989) as it is in bacterial blight of anthuriums.

Manganese also needs to be examined. However, copper may be too toxic to anthuriums for use to control the bacteria as phytotoxicity has been observed with low concentrations of foliar applied copper sulfate. The effects of boron, molybdenum, iron, aluminum, silicon, sodium, and chloride also need to be studied.

Sulfur, Magnesium, Calcium, and Soil pH

The level of sulfur in healthy anthuriums (0.19%), and deficient anthuriums (0.08%) was determined by Imamura and Higaki (1984). The levels for magnesium in healthy (0.21%) and deficient (0.08%) plants and the levels of calcium in healthy (1.16%), anthuriums were also determined. These levels were slightly lower than those of earlier researchers in Hawaii, 1.50% for calcium, and 0.75% for magnesium (Poole and Greaves 1969), but almost the same as the levels for anthuriums growing in the Netherlands: magnesium 0.35% and calcium 1.20 - 1.30% (Bik 1976; Boertje 1978). Calcium nutrition of anthuriums has also been thoroughly researched by Higaki (Higaki 1977, 1980; Higaki and Carpenter 1980). Because optimum and deficiency levels have been determined, studies should now be made to determine the effect of higher luxury levels of these elements on the resistance or susceptibility of anthuriums to bacterial blight. Higher levels of calcium may increase resistance to the blight because of the increased membrane integrity and the possibility of reduced cell wall breakdown. However, the interaction with soil pH and micronutrients must first be examined.

Phosphorus and Potassium

The levels of phosphorus has been determined for healthy (0.17%), and deficient (0.08%), anthuriums (Imamura and Higaki 1984). These levels are similar to levels reported by earlier researchers (Poole and Greaves 1969) in Hawaii (0.16%) and by researchers (Bik 1976; Boertje 1978) in the Netherlands (0.25 - 0.36%). However, we do not know the effect of higher luxury levels of phosphorus on the bacterial blight. Low phosphorus levels are presently used to control *Fusarium* on several crops. Whether phosphorus has an effect on resistance or susceptibility of anthuriums needs to be determined.

The level of potassium in healthy (3.25%) and deficient (0.57%) anthuriums has been reported (Higaki and Imamura 1984). This level for healthy plants is similar to those recommended for anthuriums (Bik 1976; Boertje 1978) in the Netherlands (2.87 - 3.07%), but higher than those earlier reported (Poole and Greaves 1969) in Hawaii (1.10%). Because higher levels of potassium generally have been reported to reduce the severity of both fungal and bacterial vascular diseases, it is important to conduct research in this area.

The Netherlands researchers recommend that fertilizer for anthuriums be in a ratio of 1 nitrogen to 2.5 potassium. Thus, potassium nitrate would be a good base from which to formulate a liquid feed. However, it is difficult to decide which potassium fertilizer to use for dry application. Potassium sulfate has a slow rate of dissolution and is also available in a resin-coated form. However, this fertilizer contains sulfur, and the effects of high levels of sulfur have not been determined for anthuriums and the blight. Potassium fertilizer is also available in the form of potassium-magnesium sulfate, but this fertilizer contains magnesium in addition to sulfur. The effects of high magnesium levels have also not been determined. Potassium chloride contains the chloride ion, which has been implicated in salt toxicity. Anthuriums can only tolerate low salt levels (Boertje 1978). This may not be a problem during high

rainfall periods, but because black cinder has a low cation exchange capacity, potassium and chloride would both leach. Potassium chloride should probably be avoided in greenhouse situations, because of the danger of salt toxicity.

Nitrogen Fertilizer: Nitrate and Ammonium Forms

The form of nitrogen, nitrate or ammonium, has a great impact on the severity of most vascular diseases. This is partially because of the different effect of nitrate ion and ammonium ion on the formation of amino compounds in the plant.

Ammonium Fertilizers

Ammonium ions are toxic to the cells of the plant (Mehrer and Mohr 1989). The plant cells detoxify the ammonium at the point of absorption by combining the ammonium ion with an organic acid or amino acid. At low levels of ammonium ion the reaction commonly involves glutaric acid (a five-carbon organic acid), glutamate (a five-carbon amino acid with one nitrogen), and glutamine (a five-carbon amide with two nitrogens). When excess ammonium ion is present in the plant cells, glutamine and asparagine are made. The two amides, glutamine and asparagine, both contain two nitrogens and thus make more effective use of carbon compounds in detoxifying the ammonium ion. However, much energy in the form of organic acids or in ATP, NADH, or ferredoxin is used in the conversion of ammonium ion to amino compounds. Thus, use of ammonium fertilizers during periods of low photosynthesis leads to less carbohydrates for formation of the pectins, hemicelluloses, and celluloses of the cell wall, a condition termed carbohydrate depletion (Bunt 1976); less carbohydrates for formation of anthocyanins for flower color (Mehrer and Mohr 1989), a condition termed bleaching in anthuriums; and a general "over-soft" growth of the shoots and leaves of the plant. In this weakened condition the plants are more susceptible to pathogens.

The amino compounds made in the root then move through the xylem from the root to the shoot. This is a very important process in plants, because this is how the shoots and leaves of the plant obtain nitrogen from ammonium fertilizers. In general, then, the use of more ammonium fertilizers causes the production of more amino compounds in the roots, and thus there are more amino compounds in the xylem and in the guttation liquid. Our group has demonstrated this process in anthuriums (Sakai 1990) and will present these results at the 1990 Anthurium Blight Conference. In 'Hawaiian Butterfly', 'Ozaki', 'Mickey Mouse', and 'Calypso' plants fed 200 ppm ammonium, more amino compounds were present in the guttation fluid than when plants were fed 80 ppm ammonium.

The fact that amino compounds are detectable in the guttation liquid is important. As the amino compounds move up the xylem from the root to the shoot, they are absorbed out of the xylem by various tissues to meet the requirements for plant growth. Therefore, the level of amino compounds in the xylem would be even higher than that of the guttation fluid. The bacteria can use the amino compounds as a food source, and with higher amounts of amino compounds there would be more growth of the bacteria. As there is constant movement of the liquid in the

xylem with transpiration in the day and guttation in the night, the bacteria in the xylem would be constantly bathed in nutrient solution (Davis, Whitcomb, and Gillaspie 1981; Van Alfen 1982). Thus, limiting the amount of amino compounds in the xylem by limiting use of ammonium fertilizers could limit growth of the bacteria. We are continuing work in this area.

The principle infection sites for *Xanthomonas campestris* pv. *diffenbachiae* are the hydathodes of the anthurium leaf. These hydathodes are located on the outer margin of the leaf and occupy only a small proportion of the total leaf surface. Two reasons can be given for bacterial infection through hydathodes. The first is that the bacteria has one flagella and is motile. Hydathodes have a continuous water pathway from the outside of the leaf to the xylem. Stomata on the other hand may have water near their openings, but free water is not usually present in the intercellular spaces. Thus bacteria can swim into the stomata, but are then not able to swim further.

The second reason for bacterial infection through hydathodes is that guttation liquid contains nutrients such as amino compounds. Virulent strains of *Xanthosomas campestris* pv *oryzae* on rice have been shown to multiply rapidly on the nutrients in the guttation liquid and enter hydathodes (Mew, Mew, and Huang 1984). Bacteria are able to detect the presence of the nutrients and swim towards the higher concentration of these nutrients to the hydathodes. The process is called chemotaxis and was first demonstrated by Pfeffer in 1888 (see Macnab 1978). In the first study, bacteria (*Bacillus termo* and *Spirillum undula*) were attracted to 1% meat extract and 1% asparagine. Subsequent workers have shown that bacteria have receptor sites which are able to detect many amino compounds including those made during the assimilation of ammonium fertilizers: glutamate, glutamine, aspartate, and asparagine (Mesibov and Adler 1972). In the plant pathogenic bacteria, the soft rot bacteria *Erwinia carotovora* subsp. *carotovora* has been shown to be attracted by 20 amino acids, with aspartate being the best attractant (Hsu and Huang 1987). The bacterial speck pathogen of tomato, *Pseudomonas syringae* pv. *tomato*, has been shown to be strongly attracted to asparagine (Cupples 1988). *Xanthomonas campestris* pv. *oryzae* also shows a chemotactic response to hydathodes of rice (Feng and Kuo 1975). We have attempted a study of chemotaxis of *Xanthomonas campestris* pv. *diffenbachiae* but have not yet developed the technique to obtain meaningful results.

Nitrate Fertilizers

Nitrate ions are not toxic to plant cells. Plant cells accumulate the nitrate ion and then convert the nitrate ion to ammonium as it is needed to form amino compounds for growth. The process of conversion involves two steps. In the first step nitrate is converted to nitrite by the enzyme nitrate reductase. This step requires molybdenum. In the second step the nitrite is converted to ammonium by nitrite reductase. This step is inhibited by diuron (Peirson and Elliott 1981). After the ammonium is formed, amino compounds are produced as with ammonium fertilizers. It should be noted that the process of conversion of nitrate to ammonium requires energy. In periods of low photosynthesis, less nitrate would be converted to

ammonium, and in periods of high photosynthesis more would be converted. Thus, the plant controls the level of nitrate conversion to ammonium in the plant. Photosynthesis and nitrate conversion are balanced, so there are never excessive levels of ammonium ion in the plant. Thus, adequate carbohydrates are available for cell wall development and strong growth of the plant. This is not the case with ammonium fertilizers.

Plants differ in where the conversion from nitrate ion to amino compounds takes place. Some plants transport the nitrate in the xylem to the leaf before converting the nitrate to amino compounds. Thus, there would be high concentrations of nitrate and only low concentrations of amino compounds in the xylem of these leaf converters. Other plants convert the nitrate to amino compounds in the root. These root converters would have higher levels of amino compounds in the xylem, but not as high as with plants fertilized with ammonium fertilizers.

The ideal situation would be for anthuriums to be leaf converters because there would only be low levels of amino compounds in the xylem on which the bacteria could feed. However, we have found for the cultivars, 'Hawaiian Butterfly', 'Ozaki', and 'Mickey Mouse' that there is conversion of some of the nitrate to amino compounds in the root (Sakai 1990). However, nitrogen is also carried to the shoot in the xylem in the nitrate form.

Of interest is that when anthurium plants were fed 200 ppm nitrate, there was more conversion of nitrate to amino compounds in 'Hawaiian Butterfly' than in "Ozaki'" or 'Mickey Mouse'. There was also more nitrate in the guttation liquid of 'Mickey Mouse' than of 'Ozaki' or 'Hawaiian Butterfly'. When fed 200 ppm ammonium, 'Hawaiian Butterfly' also produced the most amino compounds in the guttation liquid and 'Calypso' produced the least. The 'Calypso' cultivar, in our study, also did not produce any amino compounds in the guttation liquid when fertilized with 200 ppm nitrate. This then points to production of amino compounds and their level in the xylem as possible factors in resistance to bacterial blight. The very susceptible cultivar 'Hawaiian Butterfly' produced the most amino compounds with ammonium as well as nitrate fertilizers. The very resistant 'Calypso' cultivar, in our study, produced the least amount of amino compounds with ammonium fertilizer and no amino compounds with nitrate fertilizers.

The fact that less amino compounds and more nitrate is found in the xylem of anthuriums with nitrate fertilizers than is found with ammonium fertilizers points to use of nitrate fertilizers to reduce the severity of the bacterial blight. Nitrate can be used by the anthurium plant, but cannot be used as a nitrogen source by the blight bacteria (Hayward 1972). Thus, nitrate in the xylem would feed the plant and not the bacteria.

Although some cultivars convert the nitrate to amino compounds in the root and therefore carry amino compounds in the xylem, use of nitrates instead of ammonium fertilizers would reduce the level of these amino compounds in the xylem. Although nitrate fertilizers require the expenditure of more energy to convert the nitrate to

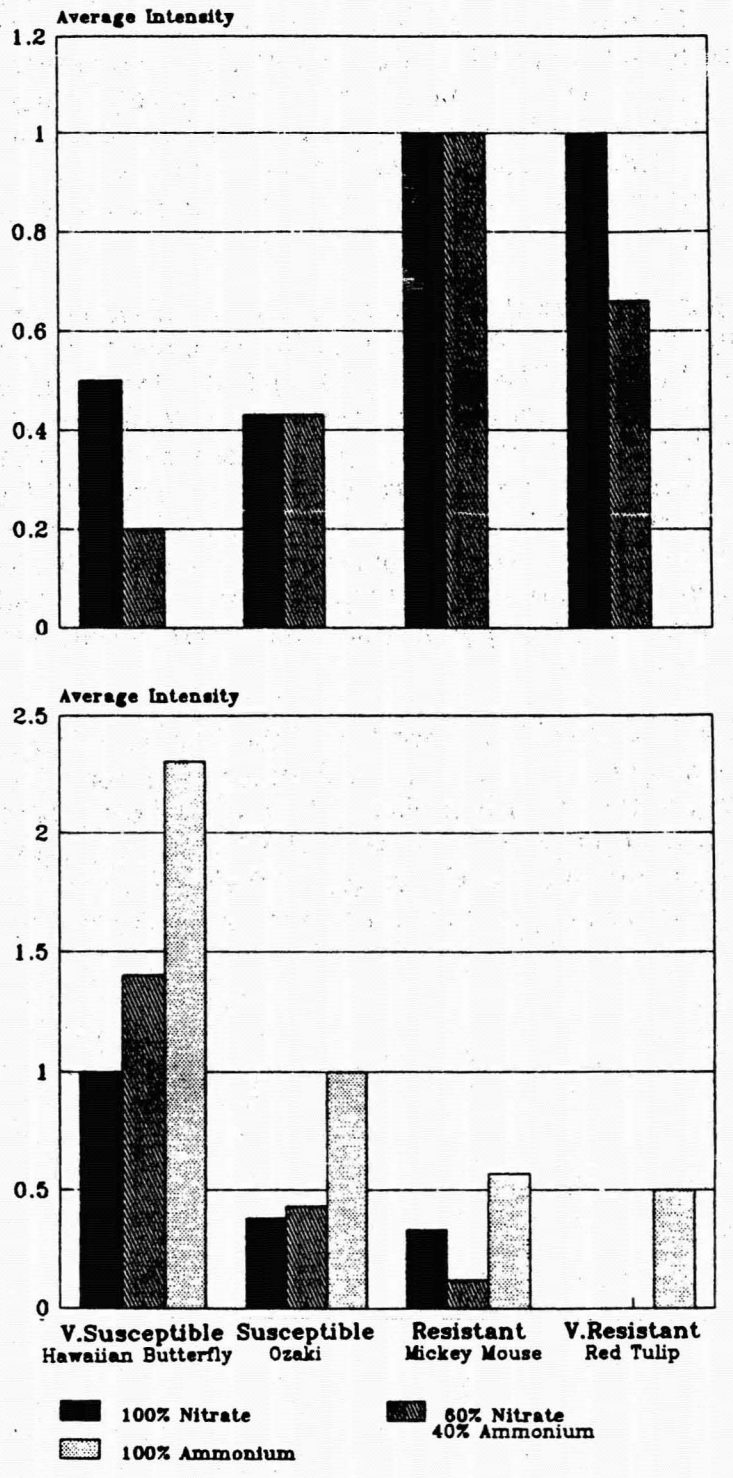

Figure 1. Effect of nitrate and ammonium fertilizers on the levels of (upper graph) nitrate and (lower graph) amino compounds in anthurium guttation liquid (Sakai et al. 1990).

ammonium (15-16 ATP per mole of nitrate), nitrate fertilized plants have been shown to produce 17 to 230% more dry matter than ammonium fertilized plants (Salsac, Chaillou, Morot-Gaudry, Lesaint, and Jolivet 1987). This decrease in production caused by ammonium fertilizers is related to the positive charge on the ammonium ion, which decreases uptake of other positively charged ions such as potassium and calcium and increases the uptake of sulfate, phosphate, and chloride ion. Use of the negatively charged nitrate ion would enhance the uptake of potassium and calcium ions and, thus, may lead to increased production and resistance to the blight.

It might also be possible to further reduce the amount of amino compounds in the xylem by reducing the amount of nitrogen fertilizers applied. In a recent study in Hilo (Higaki and Imamura 1985), 100, 200, and 400 lbs of nitrogen/acre/year yielded 6.7, 7.1, and 7.6 flowers/plant; flowers of 21.4, 23.0, and 24.4 sq. inches in size; and 15.6 16.3, and 16.9 inches stem length, respectively. There is a loss in production, flower size, and stem length with the 100 and 200 lbs. of nitrogen/ acre/year rates. However, the decrease in bacterial blight may make this lower production worthwhile. The studies conducted in the Netherlands have also shown that lower nitrogen application rates when combined with higher potassium application rates results in greater production and larger flowers with longer stems (Bik 1976).

We are continuing to study these aspects of anthurium nutrition. The prospects look good for development of a nutritional program as part of an integrated program for control of the anthurium blight. This would be similar to the program developed for control of *Fusarium* diseases. The *Fusarium* program took tens of years to develop, but from the knowledge gained from the work on *Fusarium* I am confident we can develop the nutritional program on anthurium blight in a shorter time.

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Appendix: Plant Nutrition and Vascular Disease

DISEASE - FUSARIUM

Plants: aster, carnation, chrysanthemum, cotton, cucumber, flax, gladiolus, muskmelon, radish, strawberry, tomato, watermelon

Nitrogen - Nitrate and Ammonium forms

1. Ammonium fertilizers = disease more severe
2. Nitrate fertilizer used to control disease
3. Recommendation use nitrate fertilizer
4. Recommended level of nitrogen = optimum or less for plant growth = less disease

DISEASE - BACTERIA

Plants: rice - *Xanthomonas campestris* pv. *oryzae*, green pepper - *X. vesicatoria*, cassava - *X. manihotis*, corn - *Erwinia stewardii*

Nitrogen - Nitrate and Ammonium forms

1. Ammonium fertilizers = disease more severe
2. Nitrate fertilizer used to control *Erwinia stewardii* on corn
3. Recommendation use nitrate fertilizer
4. Recommended level of nitrogen = optimum or less for plant growth = less disease

Comparison of Nitrate and Ammonium Fertilizers

Ammonium

Ammonium ions toxic to plant. Interferes with several cell reactions. Under conditions of low photosynthesis can lead to carbohydrate depletion in plant - result in weak cell walls, watery growth. Combines with organic acids to form amino acids (glutamate, aspartate) and amides (glutamine, asparagine) in root.

More ammonium fertilizer more amino compounds formed (shown for anthuriums).

Amino compounds transported in xylem to leaves and shoot to provide nitrogen for plant proteins, chlorophyll, etc.

More amino compounds in xylem - more food for vascular pathogens.

More amino compounds in xylem more amino compounds in guttation liquid.

More food for pathogen to live and multiply on leaf surface before infecting plant.

More amino compounds to attract motile bacteria - chemotaxis.

Ammonium ion has positive charge, more ammonium taken up less potassium and calcium taken up.

Nitrate

Nitrate not toxic to plant. Nitrate fertilized plants produce 17 to 230% more dry matter than ammonium fertilized plants.

Nitrate stored in cell until needed. Nitrate conversion to ammonium controlled by plant.

If high rates of photosynthesis and rapid growth more nitrate is converted - if low rates of photosynthesis less conversion - never a condition of carbohydrate depletion - always strong cell walls.

Some plants shoot converters: transport nitrate to leaf and shoot before conversion to ammonium and formation of amino compounds.

Some plants root converters: convert some nitrate to ammonium and form amino compounds in root - level of amino compounds is lower than that of plants fed ammonium (shown for anthuriums).

Lower levels of amino compounds in xylem - less food for vascular pathogens. Lower levels of amino compounds in guttation liquid results in less chemotaxis.

In anthurium nitrate as also carried to the shoot for conversion in the shoot. Higher levels of nitrate in xylem feed plant but not pathogen.

More uptake of nitrate ion which is negatively charged increases uptake of positively charged ions such as calcium and potassium.

DISEASE - FUSARIUM

Plants: aster, carnation, chrysanthemum, cotton, cucumber, flax, gladiolus, muskmelon, radish, strawberry, tomato, watermelon

Micronutrients

1. Deficiency for plant = more disease
2. *Fusarium* has high requirement for growth and sporulation.
3. Recommended level of micro- nutrients: optimal or lower for plant results in deficiency for Fusarium.

Sulfur, Magnesium, Calcium & pH

1. Sulfur - appears to have no effect as nutrient, if high pH maintained.
2. Magnesium - addition of amounts greater that the requirements of plant result in increased growth of pathogen, sporulation and virulence. Recommended level of magnesium: optimal or lower for plant results in less disease.
3. Calcium - higher levels = less disease. Reduces cell wall breakdown by pathogen. Prevents loss of cell membrane integrity and cell death. Recommended level of calcium: optimal and higher for plant results in less disease.
4. Soil pH - higher levels = less disease Higher pH less Fe, Mn, Zn, Cu available. Higher pH more Ca available. Higher pH more competing growth of soil microflora - bacteria and actinomycetes. Fluorescent *Pseudomonas* bacteria produce siderophores which chelate micronutrients - disease suppressive soils. Recommended level of soil pH = 6.5 to 7.5 in low phosphorus soils, 7.0 to 7.5 in high phosphate soils.

Phosphorus and Potassium

1. Phosphorus - levels in excess of those required for optimal plant growth = more disease. Recommended level of phosphorus = optimal or lower for plant result in less disease.
2. Potassium - increased amounts reduce severity of disease. Lower nitrogen levels and higher potassium levels produce more resistance. Recommended level of potassium = optimal and higher for plant result in less disease.

DISEASE - BACTERIA

Plants: rice - *Xanthomonas campestris* pv. *oryzae*, green pepper - *X. vesicatoria*, cassava - *X. manihotis*, corn - *Erwinia stewardii*

Micronutrients

1. Deficiency for plant = more disease
2. Zinc inhibits growth of *X. campestris* pv. *oryzae*. Seedlings with roots dipped in 2.5% zinc sulfate or 2.0% zinc oxide were disease free. Recommended level for zinc = optimum and higher for plant results in less disease.

Sulfur, Magnesium, Calcium & pH

1. Sulfur - ?
2. Magnesium - ?
3. Calcium - higher levels = less disease. Prevents loss of cell membrane integrity and cell death in pepper leaves inocculated with *X. vesicatoria*.
4. Soil pH - ?

Phosphorus and Potassium

1. Phosphorus - ?
2. Potassium - increased amounts reduce severity of disease. Bacterial blight of rice - *X. campestris* pv. *oryzae*, bacterial wilt of casava - *X. manihotis*. Recommended level of potassium = optimal and higher for plant result in less disease.

IN VITRO PLANT ACCLIMATIZATION

by
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In vitro (tissue culture) anthurium plant acclimatization, also frequently referred to as Stage IV, is a critical stage that must be handled properly. Plantlet losses are usually extremely high when appropriate measures are not taken.

Acclimatization is a conditioning process that enables the in vitro cultured plants to make the adjustment from a highly controlled and consistent environment to a significantly different and variable environment. The primary characteristics that differentiate these environments are humidity, light intensity, media, and disease control. Probably of lesser importance is a difference in light quality and in gaseous levels and constituency.

In vitro cultured plants are grown in enclosed vessels from a very early stage of their development, and their growing microclimate is usually very consistent. Humidity in the culture vessel is high, and the cultures are usually exposed to less than 200 ft-c of light with a photoperiod of 16 hours light and 8 hours dark. Their growth is supported by a broad base of nutrient constituents (1/2- or full-strength Murashige and Skoog media) either with solid or liquid medium. The plants are contaminant-free during the duration of their growth in the culture vessel.

In contrast, the field-grown environment of the anthurium plant typically includes fluctuating humidity conditions which range from less than 60 percent to 100 percent relative humidity. Shadehouse light intensity varies from one grower to another and within growing operations (cultivar related). But an average growing light environment ranges from 1500 to 3000 ft-c with a photoperiod in the range of 12-13 hours light and 12-11 hours dark. Growing media generally includes a very high percentage of black cinders with excellent water drainage characteristics but poor nutrient holding capabilities. There are a broad range of disease problems, some of which are of greater impact to the young plants. Others, which fall in the category of damping off fungal diseases, are usually not a major problem with adult plants but may cause severe damage to in vitro cultured plantlets.

Imamura and Higaki (1981) conducted a study to evaluate the transfer of in vitro cultured anthurium plantlets from flask to natural conditions. As a result of their study, they recommend the following: (1) remove the plantlets carefully from the flask and wash the agar from the roots; (2) transplant plantlets with roots intact in garden compost (fine decorative bark) medium; (3) treat plantlets with fungicide either as a preplant soak or an after-planting drench; (4) keep transplanted plants under 70-80 percent shade; and (5) maintain conditions of high humidity at all times. Stage III plantlets (in vitro cultured plantlets with roots) were used in this study.

Subsequent to the studies of Imamura and Higaki, the anthurium industry has been and continues to be severely affected by the anthurium blight disease. Primarily because of the blight, the demand for in vitro cultured plants increased significantly. Once out of the culture vessel, the in vitro cultured plantlets are as susceptible to the blight as the field grown plants. Therefore, acclimatization should be conducted under conditions that eliminate or reduce possible introduction and spread of the disease. Possible measures that could be taken during the acclimatization process are: (1) isolate acclimatization area from other growing areas that may harbor the disease; (2) use clean growing media; and (3) grow plants in a greenhouse and avoid irrigation methods that increase disease spread.

In vitro cultured anthurium plantlets were formerly available primarily, if not exclusively, in Stage III. Presently, labs are offering a 10-15 percent reduction in per-plantlet cost if purchased as Stage II material. Not only is there a cost savings, but if handled properly, Stage II plantlets may develop a higher quality root system. On the negative side, Stage II plantlets are less adaptable to the new environment until new roots are formed. The acclimatization process can be improved by growing the plantlets in a plastic tray with a clear dome cover. Rootcubes, vermiculite, and perlite can be used as clean growing media. Rootcubes conveniently fit in standard 11-1/2" x 20" plastic trays, are essentially sterile, require no mixing, and are not messy. Vermiculite and perlite are also essentially sterile but are more difficult to work with. Acclimatization can be conducted in the laboratory; if so, one month in the laboratory is usually adequate. If this practice is not practical for the laboratory, a grower could use the same tray/clear-dome procedure and acclimatize the plants in the suitable clean and shaded area (less than 1,000 ft-c). Before completely exposing the plantlets to the open-air environment, the clear dome should be unlocked and left on the plastic tray to allow for a gradual transition from high humidity to a lower humidity level. The clear dome may be completely removed after one to two weeks.

In summary, if Stage III plantlets are purchased, the procedure recommended by Imamura and Higaki should be followed. If Stage II plantlets are purchased, plantlets should be acclimatized in a clean growth medium and in a consistently high humidity environment until roots are produced. Our future studies regarding Stage II and III anthurium plantlet acclimatization will include the following: (1) light intensity; (2) irrigation systems; (3) fertilization practices; (4) clean growing media; and (5) disease control.

Reference:

Imamura, Joanne, and T. Higaki. 1981. Transfer of tissue-cultured anthurium plantlets from flask to natural conditions. College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa, Hort. Digest No. 61, pp 1-2.

A BASIS FOR A PATHOGEN-FREE ANTHURIUM PRODUCTION SYSTEM

by
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Introduction

More than 30 years ago the University of California published their "Manual 23" in response to problems encountered by that state's landscape plant production nurseries (Baker 1957). Familiarly known as the U.C. System for producing healthy container-grown plants, this publication became the bible of the nursery industry, not only in California but in other parts of the U.S. as well. Prominent in the system was a group of soilless growing mediums, mostly peat and sand, which became known as the U.C. mixes. Indeed, the U.C. System became known mostly for these media, and in some growers' minds, if they used a peat-sand growing medium, they were following the U.C. System.

Unlike Marshall McLuhan's book of the 70's, however, the medium was not the whole message. The U.C. System was a system comprising the soil mixes, soil and plant treatments, and improved handling operations. It was designed to practically eliminate the principle causes of plant losses: diseases caused by micro-organisms, principally those carried by the soil, and by high salinity. The objective was uniform, dependable production of healthy plants in containers.

Hawaii's anthurium industry has suffered major setbacks during the past decade: the anthurium bleach problem, bacterial blight (*Xanthomonas campestris* pv. *dieffenbachiae*) and increased competition from other parts of the world. Two important conferences have been held to review the blight problem, and suggestions for managing it have appeared in their proceedings (Alvarez 1988; Fernandez and Nishijima 1989) and other HITAHR publications (Nishjima and Fujiyama 1985a, b).

Plant pathologists traditionally recognize several principles in disease control: eradication, prevention, protection, exclusion, avoidance, and genetic resistance. In many recommended practices, there is overlap among these. The U.C. System successfully utilizes all of these in managing nurseries to produce healthy plants. We can learn from experiences with the U.C. System to do a better job of producing anthuriums. It will not be cheap, but compared to the losses the industry has suffered, it may very likely prove to be cost-effective.

Principal Components

Diseases are seldom unrelated to other phases of plant production. The bacterial blight is clearly related to overhead irrigation practices and to splattering by rainfall in open beds or saranhouses. The medium can also harbor the bacteria, which can be carried by the shoes of laborers or vehicles moving through the nursery. As the

bacterium also colonizes the vascular system of the plant, it can be spread by sap on the surface of knives and shears used to harvest flowers and prune infected leaves. Since most anthuriums are vegetatively propagated, cane pieces from infected plants will carry the bacteria into propagation and production blocks.

Pathogen-free planting stock. The anthurium industry of Holland was largely established from enormous quantities of seedlings, from which were selected clones meeting the demands of their markets and growing conditions. Traditionally, seed has been regarded as a method for producing disease-free plants. It is not an immediate answer for Hawaii because of the variability of seedling lines. However, should the plant breeders develop true-breeding lines with desirable characteristics, methods exist for rapid increase of these lines from seed grown in vitro (Tanabe et al. 1989).

Tissue culture provides a method for increasing clonal selections of anthurium (Pierik 1975, 1976; Kunisaki 1980). It must, however, be accompanied by methods of assaying for the presence of the blight bacteria to ensure that they are not transmitted along in culture. Fortunately, indexing methods have been developed (Alvarez and Lou 1985; Norman and Alvarez 1989) which can provide this assurance.

Major propagators of carnations, chrysanthemums, and geraniums will always maintain a special "mother block" with special restrictions for entry and extreme measures to prevent introduction of diseases. These mother blocks furnish the cuttings for the rest of their increase operations. Anthurium growers might well emulate this practice, establishing such mother blocks with indexed, tissue-cultured stock plants.

It is not enough, however, to begin with pathogen-free stock, because the methods of transmitting the blight are so varied that reintroduction of the pathogen is almost certain. Steps to prevent contamination, reduce spread by splashing water and harvest practices, and changes in cultural methods are also necessary.

When bringing new plant material into the nursery, it is a good practice to place it in an "isolation ward" for several weeks to determine that it is indeed free from disease. Such a practice has much to recommend it both in theory and experience, but few growers use it.

The growing medium. Where the U.C. System introduced a soilless medium to eliminate pathogens carried by soil-containing mixes and to enable water management to reduce salinity problems, we do not need as drastic a solution in the case of anthuriums. Anthuriums traditionally have been grown in soilless media such as cinders, tree fern chips, wood shavings, or bagasse. Such media may support the blight bacteria if introduced, but do not initially carry them.

We could, of course, move to entirely synthetic media such as rockwool (Straver 1980) or polyurethane foams, but these add to the costs of operation and do not offer advantages over existing media except for assured sterility. In the production

of liner-sized plants from tissue culture, there may be advantages to using such materials for their ease of handling and minimal transplant shock. Additionally, should irrigation systems be employed which do not send water splashing onto the medium, it may be necessary to use media that distribute water better than the very coarse cinders presently employed, and some of these artificial media meet this requirement very well.

It is important to eliminate not only the blight bacteria but also other soil-borne pests, including nematodes. Fumigants such as Nemacur have been recommended to treat ground beds before planting.

One step in developing a new system of anthurium production may be the use of pots. That anthurium will produce as well in pots as in open beds has long been known (Nakasone and Kamemoto 1962), but in pots, the medium must continue to provide sufficient aeration and water retention for good root growth. The specific values of these qualities have not been measured. Presumably, volcanic cinders can still fill the bill in containers of sufficient volume.

The production environment. The principles of sanitation have been available to anthurium growers for many years (Nishijima and Fujiyama 1985a, b), but their widespread adoption has been slow. The disease-control program must fit into the current cultural methods or the cultural methods must be changed or modified. It is the latter course which Hawaii's anthurium growers will find necessary to adopt, and the sooner, the better. A few growers have seen fit to take the expensive and drastic steps necessary and have been encouraged by the results (1989 Anthurium Blight Conf. Proc.).

Production in pots. As an alternative to ground beds, anthurium production in pots offers some advantages with respect to disease control. Individual plants are more easily removed (and replaced) when disease is identified. With direct spitter irrigation into a pot, water and fertilizer can be applied without splashing onto the foliage. Spacing can be increased as plants grow larger, so use of bench space can be maximized with tighter spacing while plants are small.

Naturally, there is a downside of pot production, too. First of all, it is expensive in terms of initial costs, extra handling, and added labor. The need for a directed irrigation system adds to the expense, but some of this can be seen as an improvement in fertilizer application methods. Potted production in itself does not guarantee freedom from diseases and insects. Weed problems are reduced, but not eliminated. Water management is a little more critical than in beds, but the choice of growing medium provides flexibility here. Extra equipment may be required to transport media, pots, and plants. However, potted plant production can be highly mechanized, with labor-saving consequences.

Raised benches. Placing potted anthuriums on raised benches greatly reduces the risks of contamination from splashing water and mud. Air circulation is generally improved in a raised bench situation, which means a less favorable environment for disease development. Access to the plants for sanitation, spraying, and other

cultural operations is facilitated. Harvesting of flowers can proceed efficiently without workers having to bend over as much. When cleared of pots and plants, benches can be quickly sterilized to accommodate new plants, whereas ground beds require more extensive effort and may have to be left vacant for two to three months to allow the population of disease organisms to decline.

Advances in rolling bench design have made it possible to use up to 95 percent of the enclosed areas in which they are built. Aisle space is created by moving the benches on rollers to create entry for the workers. The benches should not be so wide that workers must lean on the outer row of plants to harvest flowers from the middle rows.

Protected cultivation. Splashing rain and wind are responsible for the spread of pathogens in open cultivation conditions. Glasshouse growers do not face these problems because of the barriers that the roof and walls present. A suitable compromise between the openness of the saranhouse and the totally enclosed glasshouse condition would be a plastic film roof with saran-enclosed sides. The structure supporting the roof would be more like a glasshouse or chicken coop than the pipe and cable system used for saranhouses, but even here there are alternative designs which may be less expensive yet achieve the desired end. Fortunately, anthuriums do not require high light intensities, and the light lost to the overhead structure and film is surplus anyway.

A solid roof which prevents splashing by raindrops will also tend to trap heat. Low-cost fogging systems have been employed by mainland glasshouses to cool their crops. Such systems do not leave a wet film on the leaves of the plants, but cool by removing heat used to evaporate the mist. Usually, such systems employ a fan to disseminate the fog particles, and thus air circulation is also improved in the house.

The advantage to the covered structure is the control it affords over rainfall and wind. Since such space is more expensive than field or saran-covered plantings, it is incumbent on the grower to make full use of it in order to obtain the greatest production. One way to do this would be to use benches on rollers so that space is not wasted on aisles.

Structure and covering costs are major considerations, but in Hawaii, strong winds are another factor to be contended with, whether the structure is of saran, plastic film, or a woven fabric. Replacing the roof is a cost item that has to be built into the planning and budgeting equation.

Maintaining the pathogen-free environment. Recontamination of pathogen-free anthurium plants can be reduced, if not avoided, by careful training of the workers to follow procedures designed to prevent transmission of the bacteria. Management and workers must work together and agree on the importance of the sanitation practices. Training must be done and spot-checking carried out to ensure that the practices are carried out. Growers who are successfully combating the blight problem agree that communication, standardized procedures, and the discipline to adhere to the standards are what it takes (1989 Anthurium Blight Conf. Proc.).

1. Rogueing out systemically-infected plants. Rather than pruning individual leaves, remove the whole plant and replace it with another. Spot-treat the site where the old plant sat and its water emitter with a disinfectant before placing a new pot there. If infection is confined to the leaf blade (localized spotting), remove the leaf blade by breaking it at its juncture with the petiole. Leaves and rogued plants should not be discarded on the floor, but they should be removed completely from the growing environment. Workers should wear disposable gloves and disinfest them between handling diseased plants. Keep a map of the areas where disease shows up to determine if it is necessary to replace a whole section should additional infections show up.

One of the problems with rogueing is that other disorders may also resemble blight. Whole plants in pots can be collected in a quarantine site where they can be evaluated over a longer period and nondiseased plants rehabilitated and diseased ones discarded.

2. When harvesting flowers, the shears or cutting knife should be disinfected with alcohol, hypochlorite bleach, or quaternary ammonium compounds. Since it takes two to three minutes to kill the bacteria, it may be necessary to alternate sets of tools. It is a good idea to build in STOP stations along the benches to hold the disinfectant and remind the workers to take this precaution against the spread of disease. Some employers provide a belt-and-pouch system for each harvester so the tools can be carried along. The frequency of dipping and cutting can be as often as between every flower or at designated lengths along a bench. If the bench is marked with a flag to indicate when a plant has been rogued, workers can be instructed to dip their tools after each cut is made in this area.

Opinion differs on whether to remove diseased leaves and systemically infected plants while harvesting or not. On the one hand, this practice takes care of the problem while the image is fresh. On the other hand, it can slow harvest and, if workers are careless about handling diseased material, it may spread the disease to the next plant from which a flower is harvested. One solution is a special team to carry out the rogueing operation.

3. If an operation is partially under cover and partly in saranhouse space while converting over to protected cultivation, basins of disinfectant dips may be placed at the entrances to the covered areas to disinfect workers' footwear before entering. As noted by Dr. Nishijima (1989 Anthurium Blight Conf. Proc.), if nothing else, it serves as a good reminder of the importance of all sanitation and preventive measures.

4. Use of antibiotic sprays. The recommendations of the HITAHR CES as of the 1989 Anthurium Blight Conference (Nishijima 1989) are to check for resistance to the antibiotics by submitting samples to the Agricultural Diagnostic Service Center lab in Hilo, to drench the plants and root medium thoroughly as antibiotic uptake through the roots is important to success, and to use a combination of streptomycin and oxytetracycline if strains resistant to both antibiotics are present. Dr. Nishijima cautions against routine use of the antibiotics, as this will lead to a build-up of

resistant strains, and against using antibiotics as the primary control measure. Sanitation practices have the first priority.

There are literature reports of the use of some of the quaternary ammonium compounds as routine preventive sprays (Frank 1988). The efficacy of such practices has not been verified for the anthurium blight, and could lead to strains resistant to the disinfectants. Furthermore, this represents an unregistered use for the compounds.

In control of the anthurium blight, one can not expect chemical sprays to remedy poor cultural practices. To reduce the incidence of bacteria on the plants and in the environment, the most important factor is the reduction of prolonged wetness. Improving air circulation and achieving optimum water retention in the root medium are important components of managing this problem. The chemical sprays then become aides to reducing the bacterial populations.

Other Cultural Needs

While clean planting stock, clean media, and an environment which minimizes the spread of anthurium blight will do much to overcome the problem, it is necessary that other cultural practices be kept up to standard to produce a high quality crop. These include maintenance of proper nutrition; control of nematodes, insects, and weeds; and selection of more resistant cultivars as they become available.

Summary

Adaptation of the U.C. System to anthurium cut flower production will cause some major changes in the way the business operates. Still, the experience of a few growers who have begun to move in this direction parallels that of California growers who adopted the U.C. System 40 years ago. It lends itself to mechanization of many production operations. The changes to a new system provide the opportunity to train workers in desired practices and to understand the *why* as well as the *how* of what they do. Disease problems are reduced both by the new practices and by worker awareness of *how* what they do influences disease spread. Finally, the system enables the reliable production of healthy, uniform plants which should yield heavily.

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LEAF DEVELOPMENT AND ANTHURIUM FLOWER GROWTH

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Anthurium andraeanum cv. 'Kaumana' flower growth and development before and after emergence was studied. The process before emergence was long and slow. A tiny flower bud about 0.3 cm long was formed 80 days before its emergence. The whole period before emergence was divided into three phases: cell division phase, slow growth phase, and elongation phase. The characteristic of each phase was studied.

The leaf which bears the flower bud at its petiole base is called the subtending leaf. Its growth had a significant influence on the flower bud growth at its petiole base. Detaching the young subtending leaf blade resulted in an earlier flower emergence.

In late 1981, a flower development disorder referred to as "bleach" was first described in commercial anthurium fields. Impaired color development occurred in the spathe lobe area in mild cases of the disorder. In severe cases the entire flower including the spadix showed signs of reduced color development, stunting, distortion and necrosis (Bushe et al. 1987). This problem happens at various flower development stages, suggesting a disruption of the normal flower development, and seemed to be a problem associated with the development of anthocyanins before the flower emerges from the subtending leaf petiole base. The period before flower emergence has not been studied in detail (Dai and Paull 1990). In order to study the "bleach" problem, it was necessary to obtain information on the sequence and timing of spathe, spadix, and lobe development before and after flower emergence and to determine when anthocyanin synthesis occurred. The secondary objective was to determine the role of subtending leaf growth on flower bud growth before emergence. The information could suggest stages of growth that could be disrupted and lead to the "bleach" disorder.

One hundred sixty young terminal cuttings (2-leaved, 30 to 40 cm long) from three- to four-year-old plants of *Anthurium andraeanum* 'Kaumana' were obtained from a commercial grower on the island of Hawaii in June, 1987. They were harvested in the morning, received at Honolulu that afternoon, and potted into wood shavings in 16 x 18 cm pots grown under shade cloth that gave 73 percent shade. The average photon flux density was 55-70 $E/m^2/sec$. Daytime average temperatures were 20-22°C during January to April, rising to 24-28°C in the April to June period. Night temperatures were 16-22°C. Irrigation was supplied automatically from overhead sprinklers for five minutes twice a day, and relative humidity was kept in the range 60-95 percent for the whole growth study period. Osmocote (18N-2.6P-10K) fertilizer was supplied (15 g/pot) once a month. Micronutrients as Foliar-60 were applied to the medium, about 0.75 g/pot, once every three weeks. Healthy plants

with an average height (from pot level to top of the plant) of 42 cm and with about three to four fully expanded leaves (25 cm in length and 13 cm in width) were chosen at random for this study.

Plants bearing the second flower were tagged, and the length of the flower stalk (length from the flower stalk base to the junction of the stalk and flower spathe), length of spathe (junction to spathe tip) and of spadix were measured. Spadix length was measured after spathe unfurling. For study of flower growth and development before emergence, eight subtending leaves were dissected at weekly intervals from leaf emergence to the next flower emergence. Flower bud length (stem base to flower tip), spadix length (bottom to the tip of the spadix), spathe length (junction of the spathe with stem to the tip of the spathe) were measured. The lobe length could only be measured after unfurling of the spathe following heating in hot water (75°C) for 10 minutes. The flower bud age was estimated as days before and after flower emergence. The means of the length and standard deviation was calculated. Cell division was estimated using the acetocarmine stain smear technique. Subtending leaf blades from six plants, one leaf on each plant, were removed at the junction of petiole and leaf blade at different ages. The day of flower emergence from the petiole base was recorded.

The rate of CO_2 fixation and stomata aperture of the subtending leaves at various stages after emergence were determined with a LI-1600 Portable Photosynthesis System (Li Cor Inc., Nebraska). Three to six leaf blades were measured for each stage, and the means of the net photosynthesis rate and the standard deviations were calculated by the LI-1600.

The study of flower growth and development after emergence has been done by Drs. Kamemoto and Nakasone (Kamemoto and Nakasone 1963). Our study agreed with theirs; there was a leaf-flower-leaf cycle (Figure 1A), and the interval between leaf emergence varied with cultivar and environmental conditions. In our study, it took about 60 days from leaf emergence to flower emergence (Figure 1A). The new flower emerged when the subtending leaf was fully mature.

The growth and development of the flower before emergence was a long, slow process (Figure 1B). A tiny flower bud 0.3 cm long was already formed about 80 days before flower emergence. At an early stage, active cell division was detected, and it thus was termed the "cell division phase." This phase was followed by a "slow growth phase." At this phase, spathe growth slowed down, with a continuous slow growth of spadix. About 28 days before flower emergence, spathe elongation started till emergence. This period was called the "elongation phase." At this phase, anthocyanin synthesis started, first in the middle of the spathe, then spreading upwards and downwards. Intensity of red color increased rapidly afterwards. Lobe growth started at this stage. The spathe was the first part of the flower to grow rapidly, while the lobe portion was the last to develop. Even seven to 10 days after flower emergence, the lobe area still remained white.

Approximately 21 days after flower emergence, a new leaf emerged (Figure 1A). This new leaf bears another new flower. When the leaf was 14 days old (i.e. 14 days

after its emergence), the leaf blade unfolded and had a negative net photosynthesis rate (Table 1). Net photosynthesis rate increased as the leaf blade matured. The highest net photosynthesis rate occurred 42 days after leaf emergence when the leaf was fully mature (Table 1).

The negative net photosynthesis rate of the young leaf suggested that the young leaf could act as a strong sink which competed for nutrients with the young flower at its petiole base and thus suppressed the flower growth. Detaching this leaf apparently changed the relationship. Therefore, removal of the subtending leaf at a young stage resulted in earlier emergence of the flower bud (Table 2). The flower emerged 18 days earlier than the control, as the subtending leaf was removed when it was young (approximately seven to 14 days after leaf emergence). Removal of a light green leaf at day 28-35 after leaf emergence resulted in flower emergence occurring 11 days sooner than the control. Removal of an old subtending leaf (42-56 days after leaf emergence) had little effect on flower emergence. This may have a commercial value: when there is a peak demand for anthurium flower, such as Valentine's Day, detachment of the subtending leaf may increase flower production. However, a period of low yield may follow because of the sacrificing of the young leaf.

The bleach problem has not yet been solved. Anthurium flower growth and development is a long process. Disruption at any stages during the development may cause the problem. We do not know whether volcano activity is involved in the bleach problem. The absence of severe bleach now, along with high volcanic activity, argues against this possibility. In addition, treating flowers with sulfuric acid and bisulphite had no apparent effect.

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Table 1. The net photosynthesis rate and stomata aperture of developing subtending leaf.

Leaf age (days)	Net photosynthesis (CO_2 mg m_2/min)	Stomata resistance (s/cm)
14	-1.08 ± 1.08	8.3 ± 3.0
28	2.28 ±0 .72	10.7 ± 5.0
42	6.30 ±0 .54	7.0 ± 2.0

Means of three leaves ± standard deviation.

Table 2. Effect of subtending leaf removal at various times after subtending leaf emergence on flower emergence. Emergence of control flowers without subtending leaf removal was regarded as day 0.

Leaf removal, days after emergence	Flower emergence, days before control
7 to 14	18 ± 4[a]
28 to 35	11 ± 2
42 to 50	4 ± 4
Control	0

[a]Mean ± Standard deviation; n= 6.

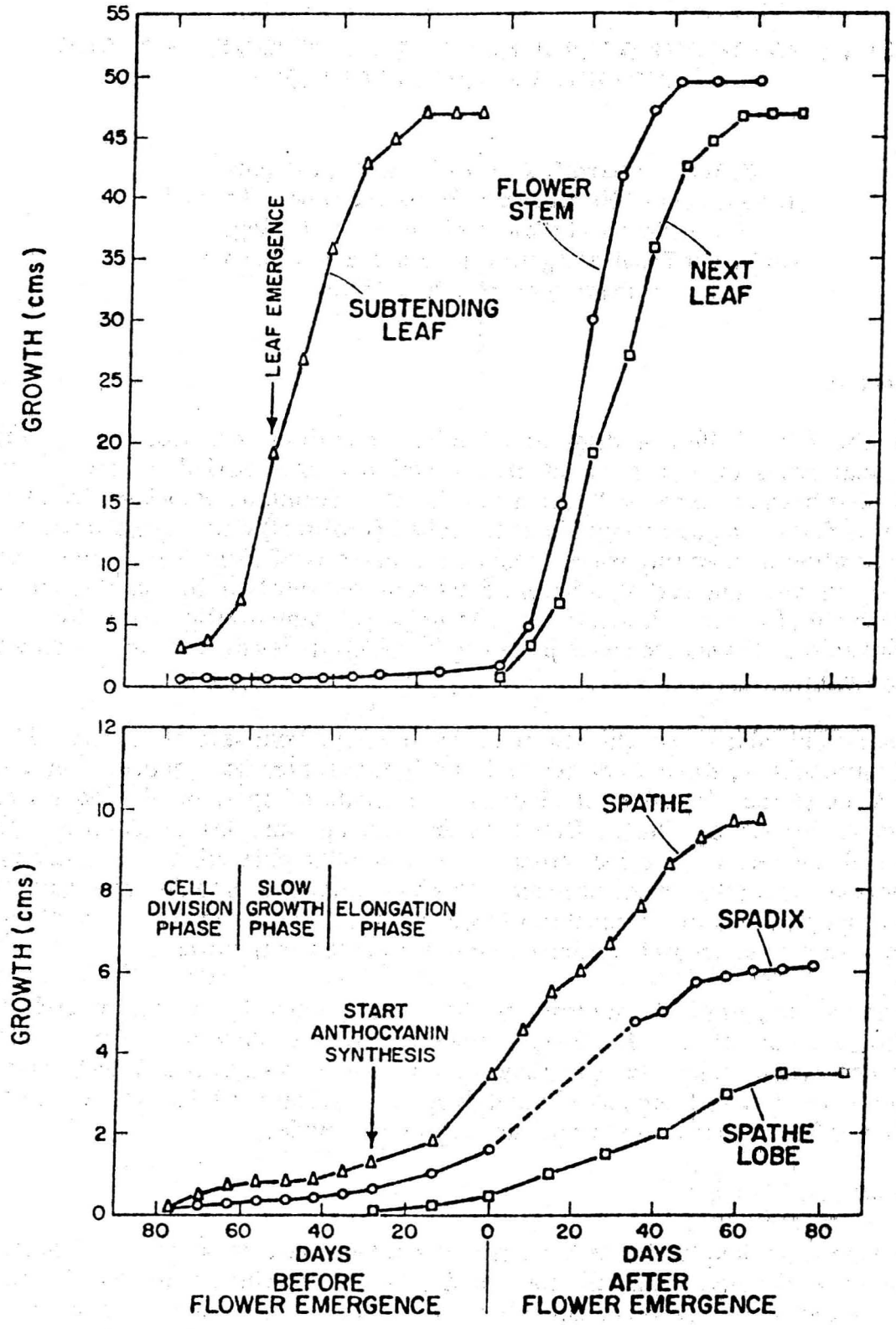

Figure 1. *Anthurium andraeanum* **'Kaumana' flower growth before and after emergence. Top: Leaf-flower-leaf growth cycle. Bottom: Spathe, spadix, and lobes growth before and after emergence. Data are the mean values of eight plants ± standard deviation.**

THE RELATIONSHIP OF TEMPERATURE AND NUTRITION TO THE ANTHURIUM BLEACH PROBLEM

by
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Introduction

During the fall of 1981 a disorder affecting anthuriums occurred on several commercial farms on the island of Hawaii within a brief period of time. The disorder has become known as "Anthurium Bleach". Symptoms associated with the disorder include unpigmentation about the lobed (proximal) portion of the spathe, unpigmentation of maturing leaves, root death, necrosis of older leaves, and poor rooting of tip and cane cuttings. Severe cases show entirely bleached spathes and a spadix devoid of florets. Producers have incurred substantial losses in the form of non-marketable flowers, reduced plant vigor, reduced flower size, and reduced keeping quality.

The anthurium industry sought help with this problem from several sources. The first comprehensive, though not detailed, nutritional survey was conducted by Dr. Harry Mills of the University of Georgia, who made a report of his findings to growers in November, 1981. Based on his findings and his experience with nutritional disorders of other crops, he strongly implicated NH_4-containing fertilizers as the sources of the problem. This contention led us to do investigations into the performance of Osmocote in cinder media, since Osmocote formulations are the most commonly used fertilizer materials by anthurium growers.

Nutrient release patterns from Osmocote have been studied by several researchers in soils and soilless media. Little work, however, has been done with Osmocote in cinder media such as that used by anthurium growers. This study was undertaken to determine the effects of temperature and time on the release of NH_4-N and NO_3-N from four different Osmocote formulations applied to cinder.

Materials and Methods

Four rectangular wooden boxes 8 x 2 ft and 1 ftdeep were constructed to contain heat produced by thermostatically controlled heating mats which were placed in the bottom of the boxes. Each box cover had 28 7-inch circular holes to accommodate 28 7.5-inch tapered plastic pots which were suspended at the rim by the box cover. A plastic funnel was affixed to the base of each pot and a plastic tube from each funnel carried the leachate out of the heat box for collection. Boxes were maintained at 70, 80, 90, and 100° F. Lighting was provided by incandescent and fluorescent lamps.

Young anthurium 'Kaumana' plants, which had been rooted and established in 4-inch pots with wood shavings six months earlier, were planted one per pot with black volcanic cinder from the island of Hawaii. Two Osmocote formulations were tested at 4 rates in the first experiment, and four Osmocote formulations were tested at three rates in a follow-up experiment (Table 1). In each experiment the prescribed amount of Osmocote was incorporated into the upper 1-inch of media and irrigated with 600 ml distilled water three times weekly. Leachate samples were collected from every third irrigation and analyzed for elemental content using standard procedures.

Table 1. Osmocote formulations tested.

Formulation	NH_4-N	NO_3-N	Projected release period
	%		month
14-14-14	8.2	5.8	3-4
14-14-14	6.6	7.4	3-4
13.5-13.5-13.5	6.08	6.92	8-9
13.5-13.5-13.5	6.6	7.4	8-9

Results and Discussion

Increased application rates of Osmocote resulted in increased recovery of both NH_4-N and NO_3-N in leachate. Increased temperatures of media resulted in accelerated release of NH_4-N and NO_3-N in leachate. Relatively low percentages of NH_4-N were recovered from the applied NH_4-N in the form of four Osmocote formulations at all temperatures tested. It is speculated that volatilization and the activities of microorganisms may have been the cause of the low percentages of NH_4-N recovered from the leachate.

Selected data summarized in Table 2 show that both NO_3-N and NH_4-N recovered from leachate increased almost linearly over time and that the higher temperature resulted in an earlier and greater total release of both nitrogen forms from 14-14-14 Osmocote.

Selected data summarized in Table 3 show that the release of NO_3-N from 13.5-13.5-13.5 Osmocote accelerated after six weeks at all temperatures and that higher temperature resulted in greater release. Release of NH_4-N increased almost linearly over time but at 90° F recovery was only slightly greater than at lower temperatures. There was no difference in NH_4-N recovery at 70° or 80° during the 9-week observation period of this trial.

Table 2. Release of NO_3-N (as percentage of total applied) from 14-14-14 Osmocote (3-4 mo formulation) at 3-week intervals and at 80 and 100° F temperatures.

	3 wks	6 wks	9 wks
NO_3-N 100°	33	66	100
NO_3-N 80°	20	40	82
NH_4-N 100°	6	12	18
NH_4-N 80°	4	7	12

Table 3. Release of NO_3-N and NH_4-N (as percentage of total applied) from 13.5-13.5-13.5 Osmocote (8-9 mo formulation) at 3-week intervals and at 70, 80, and 90° F temperatures.

		3 wks	6 wks	9 wks
NO_3-N	90°	7	17	41
	80°	5.5	13.5	33
	70°	3.5	12	30
NH_4-N	90°	2	2.5	5
	80°	1.5	2	2
	70°	1.5	2	4

Figure 1 compares the performance of identical Osmocote formulations with different resin coatings (the 8-9 mo material which is marketed as 13.5-13.5-13.5 has, in fact, 14.08% N which is formulated identically to the 14.0-14.0-14.0 material). The data show the same general pattern of increased release at the higher temperature and substantially greater recovery of NO_3-N than NH_4-N from the collected leachate. The resin coating on the 3-4 mo material does allow for more rapid release of both nitrogen forms during the first 4-6 weeks, followed by what appears to be more similar release patterns during later weeks. At 90° F over nine weeks the recovery of total nitrogen from the 3-4 mo coated material was about 49%, while the recovery of total nitrogen from the 8-9 mo material appears to be effective in delaying nitrogen release even at high temperatures.

Salinity and pH readings were recorded for each leachate sample and are presented as composite data in Tables 4 and 5.

Table 4. Mean levels of salinity and pH of leachate at different application rates (all formulations and temperatures combined).

N from Osmocote lbs/acre	Salinity mmhos/cm	pH
0	0.20	6.8
200	0.49	5.2
400	0.98	3.9
800	1.62	3.9

Table 5. Mean levels of salinity and pH of leachate at moderate (70 and 80° F combined) and high (90 and 100° F combined) temperatures (all formulations and rates combined).

Temperature	Salinity mmhos/cm	pH
Moderate	0.86	4.9
High	0.83	5.1

The data from Table 4 indicate that increasing salinity and decreasing pH may result from increased application rates of Osmocote.

The data from Table 5 do not indicate any direct relationship between salinity and temperature or pH and temperature.

Levels of NO_3-N and total N in anthurium leaf tissue from plants grown in cinder media with three rates of Osmocote at moderate and high temperatures are presented in Tables 6 and 7.

Table 6. Levels of NO_3-N and total N in leaf tissue from plants fertilized with three rates of Osmocote (all formulations and temperatures combined).

N from Osmocote lbs/acre	NO_3-N (ppm)	Total N (%)	NO_3-N as % of total N
0	583	1.41	0.042
200	549	2.66	0.021
400	1029	2.91	0.035

Table 7. Levels of NO_3-N and total N in leaf tissue from plants grown at moderate (70 and 80° F combined) and high (90 and 100° F combined) temperatures (all formulations and rates combined).

Temperature	NO_3-N (ppm)	Total N (%)	NO_3-N as % of total N
Moderate	546	2.41	0.023
High	918	2.65	0.035

The leaf tissue NO_3-N was slightly higher for the zero application rate control than for the 200 lbs N/acre application rate. This discrepancy is unexplained. At 200 lbs N/acre, total N increased from 1.41% (control level) to 2.66% and at the 400 lbs N/acre rate total N further increased to 2.91%. At 400 N/acre the NO_3-N content was nearly two times that at the the 200 N/acre rate. The 400 N/acre rate did result in the highest NO3-N and total -N leaf tissue values. Table 7 indicates that at higher temperatures the uptake of NO_3-N and total N are greater than at moderate temperatures and that NO_3-N as a percentage of total leaf nitrogen is also significantly higher.

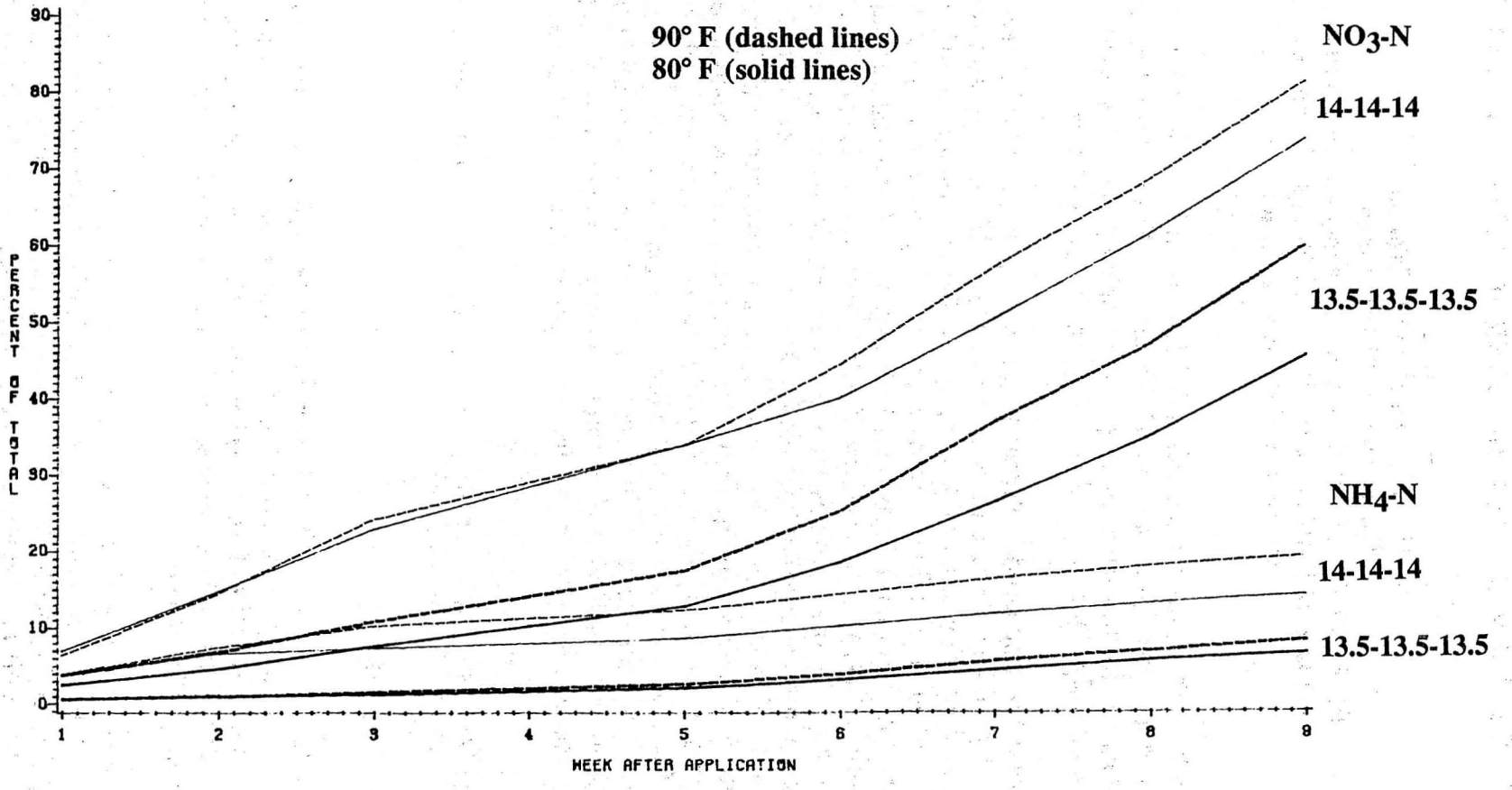

Figure 1. Comparison of NH_4-N and NO_3-N release from Osmocote formulations 14-14-14 and 13.5-13.5-13.5 at different temperatures.

SPATHE BLEACHING OF *ANTHURIUM ANDRAEANUM* LINDEN.

by
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Occasionally anthuriums on the island of Hawaii are discolored or depigmented about the lobed (proximal) section of the spathe. Root death, leaf necrosis, and poor rooting of tip and cane cuttings are associated with this condition. Severe cases show entirely bleached spathes and a spadix devoid of florets.

This disorder first appeared in September, 1981. Substantial losses were incurred by commercial producers in the form of non-markettable flowers and reduced plant vigor. In addition, decreases in flower size and keeping quality contributed to these losses. Plantings most affected were cultivated in ground beds of volcanic cinder (predominantly Puuwaawaa cinder), which has been limed and regularly fertilized with controlled release fertilizers, specifically Osmocote, which is used by a majority of the growers. Nearby plantings grown in soil, organic materials, or in older cinder beds which had been repeatedly mulched and/or tilled appeared to be somewhat less affected. This suggested that certain soil and environmental factors facilitate this condition. Other researchers have suggested ammonium toxicty, the majority of nitrogen present in the osmocote being ammonical. Anthracnose, blight, and other diseases of anthuriums have caused the use of fungicides and antibiotics, which may interfere with soil nitrification. Drought conditions may also result in less leaching of unirrigated and insufficiently irrigated plantings. These sorts of conditions can result in excessive ammonium in the rhizosphere and lead to plant ammonium toxicity.

This study was undertaken to determine if nitrogen excess plays a role in this anthurium disorder known as bleaching.

Materials and Method

Nitrogen content of tissues. The N contents of *Anthurium andraeanum* cv. 'Ozaki' were compared using data available from the Hawaii Cooperative Extension Service. Samples submitted from 1978 through May, 1981 (prior to the widespread disorder) were statistically compared by T test to samples arising from affected fields collected in late 1981.

Shoot response to nitrogen excess. Uniform cuttings of Ozaki bearing at least one flower were pulsed with various concentrations of NH_4NO_3 (9 and 15 meq NH_4^+), $Ca(NO_3)_2$ and $(NH_4)_2SO_4$ (9 meq NO_3 and NH_4^+, respectively) in flasks. Tap water was the control. Treatments were replicated four times in a randomized complete block design. Flasks were periodically weighed and refilled to the original

volume. The base of each stem was cut four times during the nine days of this experiment to reduce blockage of the transpiration stream.

Cut flower response to nitrogen excess. Cut flower of Ozaki were placed in unreplicated solutions, including the four from the previous experiment plus 24 meq NH_4NO_3. These solutions were periodically changed and the bases of the stems were removed frequently during a 17-day period. Observations were recorded every other day.

Tissue NH_4^+ analysis. Both bleached and normal-appearing flowers from two sites on the Big Island were sampled using an HNU ion-sensitive electrode and a pH/ion meter with internally programmable standards. Solutions of 1.8 and 18 ppm NH_4^+ were entered and regularly resampled. Two grams of fresh plant tissue was macerated in 20 ml of 2.0 N KCl in a large test tube. Five ml of this sample was transferred to a small beaker and continuously agitated by magnetic stirring rod. To this, 0.5 ml 1.0 N NaOH was added and the electrode inserted into the suspension. Readings were made after two minutes.

Results and Discussion

Nitrogen contents for Ozaki leaves were significanly different when the samples were compared by T test to those sampled prior to the disorder (Table 1).

Shoot response to nitrogen excess. Shoots, with leaves and flowers, pulsed with solutions of NH_4^+ plus NO_3^-, NH_4^+, or NO_3^- developed bleached spathes similar to the disorder observed in the field (Table 2). Shoots in tap water remained healthy.

Solution uptake was constant during the course of the experiment (days 4-17) following an initial period of increased uptake (day 2), possibly indicating that water spaces in the stem were depleted at the beginning of the experiment (Table 3).

Cut flower response to nitrogen excess. Cut flowers exposed to similar solutions as in the previous experiment did not develop bleached spathes. Rather, changes in spathe color from red to blue were observed. Rapid necrosis followed spathe blueing (Table 4). Calcium nitrate increased the shelf life of the flowers when compared to other treatments at the same concentration.

Tissue NH_4^+ analysis. The NH_4^+ content of affected spathes was significantly greater than that of unaffected spathes at one of the two sites (Table 5). The NH_4^+ content of the naked spadix was significantly greater than the spadix of the unaffected flower, but the tissues are so different that comparison is difficult. The NH_4^+ concentrations of the tips and lobes of the spathes and the leaves are not significantly different; however, these observations were only replicated twice.

Small sample numbers of affected tissues and lack of known standards concerning the nitrogen content of healthy plants prohibit conclusive findings. Samples submitted prior to the disorder have not been well described as to the cultural and

symptomatic reasons for tissue analysis. Other nutrients are greatly out of balance, including Ca^{++} and Fe^{++} by T test (Appendix 2), and many others by DRIS analysis. Chronic NH_4^+ excess results in carbohydrate depletion, as organic acids are aminated as a means of reducing the toxic NH_4^+ effect. This depletion can result in poor rooting of cuttings. Severe root (Hideo 1977) and leaf (Byrne and Hasek 1979) disorders are associated with NH_4^+ excess in other species.

The failure of anthocyanin pigmentation (Iwata et al. 1979) of marginally affected spathes appears to be a chronic disorder. Whether or not nitrogen nutrition is a direct cause of this disorder has not been demonstrated.

Field observations indicate that developing spathes are unpigmented rather than depigmented as was the case in pulsing shoots with flowers with excessive levels of NH_4^+ and NO_3^- in the laboratory. Cut flowers exposed to immediate NH_4^+ and NO_3^- excess through the petiole do not develop the bleaching disorder; rather, a litmus type reaction takes place as tissue pH levels raise. This blueing is followed by rapid necrosis of the spathe. Marketed cut anthrurium flowers senesce similarly.

Measurement of fresh tissue NH_4^+ (which also measures volatile amines) suggests differences between affected and unaffected spathes and spathe parts. These observations have not been substantiated by other researchers; however, differences in methodology may account for this discrepancy.

Soil analysis by Mills (1981) suggests no clear trend for flower conditions (Appendix 3). Lack of NH_4^+ analysis of affected and unaffected tissues complicate Mills' findings; however, combined plant analysis for nitrogen content also show no trends (Appendix 4).

Plant tissue ratios of NH_4^+ and its detoxifying compounds and NO_3^- as well as total nitrogen content should provide insight as to the role of nitrogen nutrition in anthurium bleaching.

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Table 1. Nitrogen content of *Anthrurium* 'Ozaki' leaf tissues[1].

Conditions	Year	%N	± $^{t}05^{sx-}$	n
Affected	1981	2.66	0.49	4
Unaffected	1980-81	1.75	0.07	41
Unaffected	1979	1.79	0.18	14
Unaffected	1978	1.83	0.13	16

[1]Source: Cooperative Extension Service, CTAHR, University of Hawaii.

Table 2. Condition of 'Ozaki' blossoms on shoots after 16 days exposure to various nitrogen solutions.

meq	Condition	Frequency	Conditions	Frequency
0 (control)	Healthy	100%		
9 NH_4NO_4	Necrotic spadix	50%	Healthy	50%
15 NH_4NO_3	Bleached lobes	75%	Healthy	25%
4.5 $Ca(NO_3)_2$	Bleached lobes	50%	Healthy	50%
4.5 $(NH_4)_2SO_4$	Bleached lobes	50%	Healthy	25%
			Necrotic spadix	25%

Table 3. Solution uptake (ml/g/day) by 'Ozaki' shoots over time.

	Day					
Treatment	2	4	6	13	15	17
Control	70.6	56.2	40.4	48.2	46.3	55.0
9 meq NH_4NO_3	70.8	50.9	44.4	39.4	33.2	41.7
15 meq NH_4NO_3	74.0	49.2	50.9	31.7	30.4	44.9
4,5 meq $Ca(NO_3)_2$	71.3	55.6	46.4	47.6	46.3	50.8
4.5 meq $(NH_4)_2SO_4$	68.1	46.8	40.0	37.8	50.2	46.7

Table 4. Frequency (percent) of cut flower spathe blueing over time.

Treatment	Days exposure			
	8	11	13	17
control	0	0	16.6	50
9 meq NH_4NO_3	0	33.3	50	100
15 meq NH_4NO_3	0	0	66.7	100
24 meq NH_4NO_3	0	33.3	100	100
4.5 meq $Ca(NO_3)_2$	0	0	0	83.3
4.5 meq $(NH_4)SO_4$	0	16.6	50	100

Table 5. Concentration of NH_4^+ in tissues of affected and unaffected 'Ozaki' anthuriums.

Condition[1]	Site[2]	Tissue	ppm NH_4^+	S.E.M.[3]	
A	I	Spadix (naked)	2.43	0.13	
A	I	Spadix	2.21	0.38	
U	I	Spadix	1.60	0.03	n.s.[4]
A	I	Spathe (whole)	2.24	0.29	
U	I	Spathe (whole)	1.49	0.14	n.s.
A	II	Spathe (whole)	3.44	0.32	*
U	II	Spathe (whole)	2.01	0.10	
A	I	Spathe (lobe)	2.13	0.27	
U	I	Spathe (lobe)	1.12	0.22	n.s.
A	I	Spathe (tip)	1.54	0.32	
U	I	Spathe (tip)	0.95	0.04	n.s
A	II	leaf	5.47	0.64	
U	II	leaf	2.10	0.57	

1. A = affected, U = unaffected
2. I = Island Tropicals, II = Gerard's farm
3. S.E.M. = Standard Error of the Mean
4. n.s. = not significant, * significant at the 95% level.

Appendix 1. Nitrogen content (%) of 'Ozaki' anthurium leaf blades from the island of Hawaii, means of *n* observations[1].

Month:		J	F	M	A	M	J	J	A	S	O	N	D	Total
1981	%	1.99	1.82		1.76	1.55					2.66			
	n	1	1		2	3					4			
1980	%	2.00		1.80	1.98	1.67		1.65		1.56	1.71		1.72	1.75*
	n	1		7	3	2		4		2	14		3	43
1979	%			1.69	1.58				1.87	1.69		2.14		1.79
	n			3	2				4	3		2		14
1978	%	1.44	1.80		1.92		2.00		2.13					1.83
	n	3	2		9		1		1					16

[1]Data from Hawaii County CES, CTAHR, University of Hawaii.
*Includes data from 1981, January through May.

Appendix 2. Calcium and iron contents of 'Ozaki' anthurium leaf blades[1].

	Ca %	Fe (ppm)
Oct. 1981	1.32 ± 0.16	81.5 ± 12.6
1980	1.04 ± 0.12	130.8 ± 8.4
1979	0.91 ± 0.18	135.6 ± 8.5
1978	1.12 ± 0.18	115.3 ± 11.8

[1]Source, CES, CTAHR, University of Hawaii, 'Ozaki' from island of Hawaii.

Appendix 3. Nitrate and ammonium content of anthurium soils[1].

Site	Plant Conditions			
	Unaffected		Affected	
	NO_3	NH_4	NO_3	NH_4
Island Tropicals	50	20	50	24
	14	1	44	20
			100	16
Kualoa Farm	100	15	78	22
			20	1
			22	1
Hale Nui	12	1	18	1
			1	1

[1]Source: H. Mills, University of Georgia.

Appendix 4. Percentage total nitrogen of shoots, leaves, and flowers[1].

Site	Percent N	
	Affected	Unaffected
Island Tropical	1.32	1.08
	1.32	1.33
	1.09	
Kualoa Farms	1.19	1.27
	1.14	
	1.15	
Hale Nui	1.08	1.08
	1.14	

[1]H. Mills, Univeristy of Georgia. From combined samples of 'Ozaki' anthurium.

NEW DENDROBIUM CUTFLOWER CULTIVARS AND SELECTIONS

by
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We have continued to emphasize the development of improved seed-propagated cultivars in our dendrobium breeding program. Other breeders, especially in Thailand, have developed excellent clonally propagated cultivars. The major advantages of seed-propagated cultivars over clonally propagated cultivars in Hawaii are: 1) propagation is faster and cheaper, and 2) the offspring are free of cymbidium mosaic virus--a widespread and readily transmittable orchid virus.

Amphidiploid Cultivars

Success in developing seed-propagated dendrobium cultivars depends on the utilization of amphidiploids (tetraploids with two sets each of two different genomes; e.g. tetraploid *D.* Jaquelyn Thomas with two sets of *D. phalaenopsis* chromosomes and two sets of *D. gouldii* chromosomes). The early UH releases are amphidiploid cultivars: Jaquelyn Thomas UH44, Jaquelyn Thomas UH232, Jaq-Hawaii UH306, Jaquelyn Thomas UH503, and Jaquelyn Thomas UH507 (Kamemoto 1985).

During the past few years we evaluated 16 amphidiploid combinations, hopefully to obtain additional cultivars which might complement the available cultivars and to possibly reduce the peaks and valleys of seasonal yields (Kamemoto, et al., 1989). The five UH cultivars were among the eight highest yielding progenies. UH800, a cross between our inbred Jaquelyn Thomas K159-21 and Jaquelyn Thomas D192 obtained from Thailand, performed equally as well as UH306. This cross (UH800) was named Jaquelyn Thomas 'Uniwai Mist', and seed pods were released to the dendrobium industry (Kamemoto et al. 1990).

UH1002 is a promising new cross which produces larger flowers with stronger blush than UH44. This is a cross between a blush segregant of UH232 and an inbred selection of UH44 with a strong blush. Evaluation is continuing. In the meantime we will remake the cross for trial by growers as soon as the parent plants come into flower again.

PPPC-type Cultivars

Two PPPC-type hybrids were recently named and seed pods were released. These have roughly three sets of *Phalaenanthe* (P) chromosomes and one set of *Ceratobium* (C) chromosomes (Kamemoto et al. 1990).

UH955, *D.* Joan Kushima. UH955 is a cross between amphidiploid Jaquelyn Thomas 'Y166-1' and tetraploid *D. phalaenopsis* 'W15-6.' The lavender-pink flowers are attractive and fuller than the typical Jaquelyn Thomas type cultivars because the offspring have three P (*Phalaenanthe*) genomes and one C (*Ceratobium*) genome.

The improved individual flower quality is accompanied by seasonal flowering in fall, both of which are influenced by the *D. phalaenopsis* parent. Also, the total yield is lower than that of Jaquelyn Thomas type cultivars. Despite its seasonal flowering behavior and relatively low yield, UH955 has been released because of its attractive flowers carried on long straight flower stems.

UH971, *D.* Elaine Harada. Unlike UH955 which peaks in September and October, UH971 has shown good flower production from September to March. Flowers are attractive dark red-purple. It is a cross between tetraploid *D.* Kaimuki Beauty 'K119-24' and *D.* Jaquelyn Concert 'D239-1.' Flower characteristics other than color are similar to those of UH955. Although bud drop percentage is high, its flower production in winter is a highly desirable feature. This cultivar can serve several purposes: cut sprays, individual flowers, and flowering potted plants.

PPC Hybrid

D. Ted Takiguchi crossed to amphidiploid *D.* Neo Hawaii yielded a triploid (PPC) progeny with about two sets of P and one set of C chromosomes. The progeny segregated into white with purple lip (similar to *D.* Youppadeewan) and white in a 1:1 ratio. Sprays are long and full. This promising cross, UH1041, will be released for trial by interested growers.

Macrobig Hybrids

D. macrophyllum (LL) of the *Latourea* section was crossed to *D. bigibbum* (PP) of the *Phalaenanthe* section in 1966 to produce a PL hybrid which we registered as *D.* Macrobig. Subsequently, we selected a diploid offspring, mericloned it, and treated the protocorm-like bodies in culture with colchicine to produce an amphidiploid Macrobig with the PPLL genome constitution.

Amphidiploid Macrobig was crossed to amphidiploid *D. superbiens* (PPCC) to give rise to *D.* Carolie Simone (Kamemoto et al. 1986). The attributes of *D.* Carolie Simone are the attractive red-purple flowers with white edges, and more importantly, the winter-spring flower production. *D.* Carolie Simone is a PPCL tetraploid with two P genomes and one each of the C and L genomes.

Other Macrobig hybrids also seem to flower during winter and spring. We have been evaluating several Macrobig crosses with tetraploid *D. phalaenopsis* types as the male parent. Flowers of offspring are attractive, but bud drop percentage is high.

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DECOMPOSITION OF GRAVEL GROWING MEDIA FOR DENDROBIUM AS A POSSIBLE CAUSE OF DENDROBIUM DECLINE

by
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Introduction

Adult dendrobium plants frequently are afflicted with a disorder commonly known as "dendrobium decline." Symptoms include inactive roots which turn brown and die, yellow leaves and defoliation, reduced plant vigor, and reduced yields. Disease diagnosis has been unable consistently to associate a primary pathogen, although as decline sets in, the afflicted plant becomes increasingly susceptible to a variety of pathogens and pests. We believe the disorder is of a physiological nature caused by environmental and/or chemical stresses within the root environment. One hypothesis holds that decomposition of the basaltic blue rock used as the growing media by commercial growers may be causing or contributing to the decline.

Most gravel growing media, after a few years' use, sheds a fine silty material that accumulates in the bottoms of dendrobium containers. The notion that toxic metals such as copper may be concentrated in this "pot sludge" prompted an investigation into the nature of the sludge and the chemical composition of the gravel most commonly used as a growing media.

It is known that dendrobiums have a phytotoxic reaction to copper-containing fungicides. The possibility that some gravel may be releasing copper into the sludge to levels that could initiate decline needed to be investigated. The hypothesis was that the roots in direct contact with the gravel probably would not absorb enough copper to pose a problem. As the plants matured, however, and roots matted in the sludge at the bottom of the containers, the possibility became greater that the roots might be exposed to dangerously high levels of copper.

To explore the high-copper concentration hypothesis, gravel from the Kapaa quarry near Kailua was analyzed. The analysis consisted of exposing the gravel to a 1 Normal solution of hydrochloric acid for 48 hours. The acid solution was then analyzed for copper as well as sodium, magnesium, aluminum, phosphorous, potassium, calcium, manganese, iron, and zinc. In the case of pot sludge, the samples were divided into two subsamples. One subsample was analyzed by X-ray diffraction for its mineral content. The second subsample of sludge was treated with 1 N hydrochloric acid in a manner identical to the gravel and then analyzed for the above elements. Other metals such as vanadium and chromium were also suspected of being toxic to dendrobium. Acid extracts from both the gravel and the pot sludge were analyzed for vanadium and chromium. Only minute traces of these metals were found.

In addition to the gravel and sludge samples from the Kapaa quarry, gravel from quarries in Hilo and Kona on the island of Hawaii were analyzed. Sludge samples from Hilo and Makakilo gravel were also analyzed.

Table 1. Analysis of 1 N hydroctonic acid extracts of basaltic gravel and its sludge.

	Percent					Parts per million				
	Na	Mg	Al	Ca	Fe	P	K	Mn	Cu	Zn
Gravel										
Kapaa	0.02	0.30	0.36	0.51	0.39	77	18	123	25	10
Hilo	0.07	0.17	0.32	0.43	0.14	874	55	20	62	2
Kona	0.04	0.78	0.09	0.13	0.65	30	46	127	20	4
Sludge										
Kapaa	0.008	0.25	0.34	0.25	0.42	1,160	85	466	36	54
Hilo Red	0.03	0.08	0.28	0.31	0.12	1,350	10	133	49	28
Makakilo	0.03	1.98	0.42	0.52	2.67	1,600	200	1,660	123	111

Abbreviations:
Na = Sodium; Mg = Magnesium; Al = Aluminum; Ca = Calcium;
Fe = Iron; P = Phosphorous; K = Potassium; Mn = Manganese;
Cu = Copper; Zn = Zinc. 10,000 parts per million = 1 percent.

Discussion

The Hilo sludge that was submitted for analysis was a red cinder material that was entirely different in color and in chemical composition from the Hilo gravel. Therefore, the analyses of the Hilo gravel and sludge cannot be compared. The Hilo red cinder sludge contained no clay minerals. The red sludge contained only feldspar, volcanic glass, and organic matter. High levels of phosphorous in the three sludge samples reflect an accumulation of phosphorous applied as fertilizers. Although potassium was most certainly applied to the crop, only 10 parts per million potassium was extracted from the sludge. The trace of potassium found in the Hilo red sludge is evidence that the potting gravel fines have virtually no nutrient holding capacity and, therefore, cannot concentrate copper or other toxic metals.

The Kona gravel released high concentrations of magnesium and iron, which reflects a high concentration of olivine. The Kona gravel submitted for analysis was very fresh, indicating that it was collected from an area of recent volcanic activity. The material would not be likely to concentrate metals, and the analysis showed no evidence that toxic metals could be released.

Kapaa gravel and sludge is a material that has been altered from the original basaltic rock by the action of heat and water, a process called hydrothermal activity. Over a period of perhaps several million years the rock has been "chloritized," that is, altered to clay minerals called smectite and a mixture called chlorite/smectite. Although, chlorite has a small ion exchange capacity, smectite has a very high ion exchange capacity, meaning that sludge from the Kapaa gravel does have a potential to concentrate plant nutrients as well as toxic metals. Fortunately, the specimen of sludge from Kapaa gravel that was submitted for analysis did not show an accumulation of copper.

Makakilo sludge produced the most interesting results of the samples submitted to date. X-ray diffraction showed that the fine material was almost pure smectite! Smectite is the name for a group of minerals that swell when wet and shrink when dry. In addition to their shrink/swell properties, smectites have a high cation exchange capacity, meaning that they have a strong capacity to adsorb and then exchange positively charged ions such as metals. The chemical analysis indicated that the smectite contains a high iron and magnesium content and very low concentrations of aluminum. This particular smectite is called nontronite. The Makakilo fine material released the highest copper concentration of the six samples analyzed: 123 parts per million.

Conclusions

On the basis of the analyses of the six dendrobium growing media that have been analyzed, we see nothing in the data, with the possible exception of that for the Makakilo sludge, that would indicate a possible hazard to the production of dendrobium.

We have not determined the effect, if any, of 123 parts per million copper on dendrobium plants. Future research will include observations of plant performance at commercial nurseries where the Makakilo gravel is used as a growing media.

On the basis of the data generated to date, we believe additional work in this area is appropriate. In order to assess the potential risks associated with gravel growing media, it must be determined whether copper is native to the smectitie or whether it resulted from applications of fertilizers and fungicides and became concentrated by the exchange action of the smectite. This is accomplished by comparing extractions and diffraction data from used and unused gravel and fines from the same quarry. Finally, there must be a biological basis for making any risk assessments and recommedations. This is accomplished by conducting a copper sensitivity trial whereby deficient, optimum, and toxic copper concentrations in the media and plant tissue are determined.

DENDROBIUM CULTIVARS AND PRODUCTION TECHNOLOGY IN THAILAND

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Thailand is situated between latitude 5'37" and 20°27'N and between longitude 90°22' and 10°537'E, between India and China. The location is considered an eastern tropical climate.

Thailand has an area of 513,142 square kilometers. The length from north to south is double the width. Almost half of the area is lowland and flat; the rest is high mountains, swamp, lake and coastal shoreline on The Gulf of Thailand, the China Sea, and the Andaman Sea.

The general climate is hot and humid, but distinct rainy and dry seasons alternate, with some fluctuation in temperature. The southern part has the majority of rainfall, almost throughout the year. Rainfall is fair in the Central Plain and less in the north. Average rainfall is above 1,000 millimeters. Highest rainfall is between June and August. There are three seasons: summer, rainy, and winter. Winter, however, can be found only in the north and northeast at high elevations, with an average low of 10°C and an average high of 20°C. The Central Plain has an average low of 20°C and an average high of 30°C.

Orchids are grown mostly in the Central Plain around Bangkok, and the majority are dendrobium. Production locations have often replaced former vegetable farms, constructing benches and adding bamboo shade between 30 and 50 percent (or, more recently, saran net).

Orchid cut flower production in Thailand had grown and improved rapidly between 1970 and 1975. During that period the cost of investment and land prices were still low compared to 1985 and 1986.

Table 1. Cost of investment and income comparison.

Size of farm	Income (US $)	Cost of investment (US $)
1 Rai (0.40 acre)	2,160	2,270
2 Rai (0.80 acre)	3,190	1,751
5 Rai (2.00 acre)	2,801	1,491
Average/Rai (0.40 Acre)	2,717	1,840

(Data from Kasetsart University)

Table 2. Export value and orchid production area.

Year	Area(acres)	Value
1982	2,895	13.724
1986	4,320	15.968
1988	5,200	20.148

Source: Thai Customs

Good Location

One reason Thailand can produce cheap and good quality orchids is the prime location of the Bangkok area. The deep bay of the Gulf of Thailand plays a major role in absorbing several monsoons. Some blow away and cool down the plants during the night, some bring rainfall and humidity during the dry season, and some prevent the heat and cold waves from the north. The Bangkok area seems to be a basin that takes all the good things and is protected by natural phenomena except that too much rainfall causes floods in six-year cycles. Good farmers always look for good water supplies to pump in.

Good Varieties

As 'Pompadour' was the perfect variety for most of the markets for a long time, new varieties are slow to replace it. Improvement is done by selecting strong mother plants to increase for new plantings. Some may use tissue culture, but most do not, since the flower value is still good and plentiful mother stock is still available to select good cane.

Breeding and selection became successful in 1980, fortunately occurring in a time when the market almost faded away. Five varieties were bred and selected for the new generation of the orchid cut flower industry of Thailand. They are 'Bom', 'Anna', 'Venus', 'Sabien', and 'Panda'. Most of them meet the standards of cut flowers: attractive color, easy and fast growing, good production, and long lasting.

Unfortunately, commercial ways of hybridizing do not reveal the pedigree like in the old time. We can only guess from the rumor that most of the crosses come from *D.* Ceasar 4N, *D.* Lim Chong Min x, *D.* Drakekubo (4N), and others.

'Bom' (or 'Sonia') are of the new generation that have replaced around 70 percent of total production. My effort to make 'White Bom' had been carried out half-way. 'White Ceasar' was selected from tissue culture mutation, treated with colchine to produce the 4N. The next step is to treat a good white to be 4N and cross to get 'White Bom'. The process seems easy but it may take another three to five years to attain the goal, and also it depends on luck to have the ideal cut flower like 'Bom'. All this process may take at least ten years, but it may pay off someday.

Advanced Technology

Tissue culture laboratories play a major role in orchid cut flower production. Most farmers realize it is the fastest way to multiply and get a clean, faster growing plant.

Mature plants in bottles are hardened for four to six months, planted into "coco-ball" for intensive care, and grown to full production in 2.5-year cycles.

The whole cycle needs punctual maintenance. Young plants to six months old need more water and fertilizer. Mature plants have to be watered thoroughly to the inner row.

Proper formulas of fertilizer have to be applied for each of the growth stages, with high nitrogen for young plants and high potash for mature ones.

Insect and fungicide sprays are a protective program and have to be sprayed before the rain, sometimes even three times a week, to cope with the new rust disease and the new bud-borer. Proper combinations and sometime double dosages can prevent these. Fast and short intervals between each spraying may have to be done once the symptoms show.

Coco Charcoal Media

There are many growth medias in Thailand and each has a different cost and result, but the common coco-laying seem to be the most popular one. Common coco-laying is cheap, gives best production but is susceptable to too much moisture in the 2nd year. Coco-Pack is cheap and easy-to-manage, but only fair production. Coco in 4-inch pot gives best production in the second year but cost almost double. Charcoal in 10-inch pot gives best production but costs even more.

My idea of improving media developed last year when we could not get any good flowers or longer stems once the plants turned mature, and the problem seemed to come from too much moisture in the media.

I looked at mature dendrobiums in the wild: roots creep on the bark, there is dormancy (sleep) during the dry season, they store the food in cane and produce new cane with new and unspoiled roots.

I evaluated several growing media, local and international, like stone culture, hydroculture, and charcoal culture from the old times.

My conclusions came last year after a survey of dendrobium growing techniques in Okinawa. We know they are good growers, and the Japanese government supplies both financial and technological aid.

All kinds of media have been tried, and we ended up with charcoal after the last trial on charcoal-mix hydroball. The reason to this may be that dendrobium roots are aerial with sponge or velament cover, and charcoal gives the best conditions for

them since it balances the moisture (but not in the dry season) and it maintains dormancy and does not produce enough flowers in the off-season, Coco media gives more moisture content together with self nutrition and breaks dormancy (sleep), but has a worse effect when over-watered or there is too much rainfall; we need another 2-4 inches of healthy stem when the plants mature.

Coco-charcoal media shows promising performance after eight months of trial: the root system is normal and clear white compared to coco media, white film of algae can be noticed, growth rate is the same as coco but the color of the plant also looks bright and healthy and clean. Maybe because of its loose texture, the moisture content can fill more than normal charcoal.

Handle with Care

Postharvest handling for quality orchids has to manage them properly and move them from fresh cut to farm grading and packing to the export packing house as fast as possible. The following are steps of handling: cut and carry in a soft bag to the farm house, grade and bunch, box, and wrap with wet cloth, and quickly transport to the export packing house.

Conclusion

Thailand can continue to be a leader in orchid cut flowers for a long time due to some major factors: good geographic location, skillful farm management and abundant good work force, and cheap and easy-to-find good growing materials.

The orchid industry for export needs to be patient and have sharp eyes, plus be lucky, in combination. Future competition may need high-technology and genetic engineering, which may result in stronger plants, year-round production, and wide range of color due to a broader scope of hybridizing intergenerically by means of cell fusing.

MAINLAND WHOLESALERS' AND RETAILERS' PERCEPTIONS OF HAWAII DENDROBIUM ORCHIDS

by
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In 1989 surveys were sent to over two thousand mainland retail florists and three hundred wholesale florists to identify their perceptions regarding the strengths, weaknesses, and usages of Hawaii's dendrobium orchids. The sample included the twenty top statistical metropolitan areas in the mainland U.S. Virtually all major geographical areas of the mainland were included. Over 500 retail surveys were returned for a usable response rate of approximately 28 percent. A little more than 100 wholesale surveys were returned for a response rate of approximately 30 percent.

The surveys were designed to serve two purposes. The first was to identify wholesalers' and retailers' attitudes towards Hawaii's dendrobium orchids. The second was to identify areas in which Hawaii's dendrobium producers and marketers can make improvements or have opportunities for growth. I would like to highlight some of the findings, based upon our initial analysis.

Tropical Flowers Handled by Retailers

Retailers were asked to indicate which tropical flowers they handle. As is shown in Figure 1, the great majority of retailers handle a wide assortment of tropical flowers. But as is shown in Figure 2, the majority (56.1%) of retailers have annual tropical flower sales of less than $25,000. This seems to indicate that while tropical flowers are widely used, they are not a major item. Our results are preliminary, and further analyses may give different results when based on store size (for example by total annual sales of all flowers) or by geographical location.

Annual Sales of Tropical Flowers by Wholesalers

With respect to the assortment of tropical flowers handled by wholesalers, their responses were very similar to those obtained from retailers (Figure 3). Figure 4 gives the percentage breakdown of responding wholesalers by selected sales categories. Again, in terms of the general pattern, their responses are similar to the retailers'. The relatively large percentage of wholesalers with small annual sales (less than $25,000) may indicate that grower-shippers sell a significant portion of tropical flowers directly to the florists rather than through wholesale market channels. However, we again caution you that these results are preliminary.

Although most wholesalers and retailers handle dendrobium orchids (about 90%), these levels are probably higher than for the total industry. As compared to

respondents, it is probably safe to assume that those who chose not to respond are less likely to carry dendrobium orchids.

Marketing Activities Conducted by Wholesalers and Retailers

Retailers and wholesalers were asked to specify their most common marketing activities (Figures 5 and 6). This question was designed to identify the most common ways that the retail or wholesale florists reach out to their customers to sell their products. This information can provide guidance to Hawaii's dendrobium orchid marketers as to what efforts would best assist mainland wholesalers and retailers in creating sales of Hawaii dendrobium orchids. A maxim of marketing is that the easier you make it for your customer to sell your product, the more likely you are to make the initial sale.

In the case of retailers, personal sales, advertising (most likely yellow pages), and wire services are most often used. The industry should consider the development of a merchandising kit so that point-of-sales materials are more often and more effectively used, and so that retailers are better educated about Hawaii dendrobiums. Furthermore, it may also be effective if the industry can develop methods to assist retailers in advertising which features Hawaii dendrobium orchids.

Wholesalers use advertising and point-of-sales material to a lesser degree. Not surprisingly, personal sales are also their major activity. While printed materials are still useful, perhaps the best assistance that can be given to wholesalers is consistency and reliability in supply, and quality and information on handling as is shown in Figure 8.

Factors Affecting Retailers' Purchase Decisions

Retailers were asked to rank what factors they consider to be important when making flower purchase decision. Their responses are shown in Figure 7. The five most important factors (quality, shelf life, availability, customer request, and price) are not surprising. It is extremely doubtful that Hawaii can ever compete on a price basis. Hawaii can compete on the basis of the other four factors and consistent supply, however. It is generally held that Hawaii dendrobiums already have superior spray length as compared to others.

That customer request is a major factor in determining what retailers will purchase is important. It supports the contention of many that Hawaii's promotional programs must also reach the final consumer. However, this idea must be tempered by the extreme costs of designing and implementing these types of promotions. Some form of pilot program, such as a target city, should provide more information on the impacts of a consumer-oriented promotional program along with its costs.

The bottom six factors, U.S. grown, cooperative advertising, supplier promotion, wire service, and trade show promotion were not especially important. If this is indeed the case, then the industry might want to evaluate its present promotional and marketing efforts. One must keep in mind that fully a third of mainland retail

florists did not know where their dendrobium orchids came from. Thus, it is important to consider whether it is their ignorance of Hawaii which gives the image of Hawaii its relative low importance.

Factors Affecting Wholesalers' Purchase Decisions

Wholesalers were asked to indicate the importance of various factors in their purchase decisions. The results are shown in Figure 8. The four top items (price, customer request, handling requirements, and full product line) can be categorized into those which reduce costs and those which are in response to providing service. Obviously, these categories are not mutually exclusive. These results suggest two major thrusts. One is to educate the retail florists about Hawaii dendrobiums so that they will demand them from the wholesaler. The second is to emphasize and/or improve the ease in ordering and handling of Hawaii dendrobiums.

The bottom five items may be a cause of concern to the local industry. Four of these items, exotic image, U.S. grown, image of Hawaii, and trade shows, are either areas in which Hawaii should excel or is devoting a considerable amount of effort. Yet, wholesalers don't find these factors important. However, we shouldn't conclude that these factors can be ignored. They're simply not as important as the other factors. They still may be indications of where improvements or increased efforts need to be made. One recurring theme is the relative lack of identity which Hawaii dendrobiums have on the mainland. Exotic and Hawaii images, and an emphasis on U.S. may be useful tools when establishing Hawaii's dendrobium orchids' identity.

Neither wholesalers nor retailers ranked trade shows high as a decision factor, so it appears unreasonable to expect day to day decision making to be greatly affected by more emphasis on trade shows. One would expect trade shows to improve the recognition of Hawaii dendrobiums, but without the complete promotional package they may be ineffective.

Wholesalers' Sources of Dendrobium Orchids

Wholesalers were asked to indicate the proportion of their total supply of dendrobium orchids they get from various sources (Hawaii or foreign country). The results are presented in Figure 9. With respect to the number of wholesalers, Hawaii and Thailand, as expected, were the major sources of supply. A larger number of wholesaler indicated they get the majority (76-100%) of their supply from Thailand as compared to Hawaii. Some caution must be used in interpreting these results. They do not account for difference in firms' sizes. Thus, the wholesalers who get the bulk of their supplies from Thailand could be larger or smaller firms. Analysis is currently being run to account for firm size as well as the geographical location of the firms.

Retailers' Source of Dendrobium Orchids

Mainland retailers were also asked to indicate the source (by point or origin) of their dendrobium orchid supplies. The results presented in Figure 10 have been

corrected for those who did not know their source. It is important to note that almost 30 percent of the responding retailers did not know the place of origin for their dendrobiums. It is unreasonable to expect retailers to ask for Hawaii dendrobiums if they do not know the difference. Hawaii marketers must do a better job identifying their orchids as well as assisting wholesalers and retailers in the product movement.

Interestingly, when compared to wholesalers, retailers appear to be more dependent upon Hawaii as a supplier. There could be several explanations for this apparent discrepancy. First, many retailers might have purchased directly from Hawaii. Second, they might have been more likely to patronize wholesalers who rely heavily on Hawaii sources either by random chance or because such wholesalers are larger in size. Third, retailers may be mistaken regarding the source, and fourth, there is a tendency in answering surveys to give the answer the surveyor wants.

The results from these two questions further highlight the need for Hawaii's marketers to maintain the identity of its orchids throughout the marketing system.

Wholesalers' Comparison of Hawaii Dendrobium Orchids

Mainland wholesalers were asked to compare Hawaii's dendrobium orchids to those from other sources. The results and characteristics over which they were asked to base their comparisons are shown in Figure 11. Overall, Hawaii's dendrobium orchids compare favorably on most items, but the bottom factors identify areas for improvement relative to its competitors. Wholesalers may be willing to pay a higher price if they believe the level of service associated with the product merits it.

Retailers' Comparison of Hawaii's Dendrobium Orchids

As in the case of wholesalers, retailers were asked to compare Hawaii's dendrobium orchids to dendrobium orchids from other sources (Figure 12). If one considers those variables where Hawaii's orchids are perceived as being far superior (5) to no different (3), Hawaii does reasonably well in all categories. Alternatively, if one concentrates on those areas where Hawaii does relatively poorly (far worse (1) and worse (2)), some of the same variables previously identified keep occurring, i.e., range of colors, availability, ease of ordering, supplier responsiveness and consistency, price, etc. These results highlight the need to continue to re-emphasize and improve service. They also illustrate that the level of service Hawaii is able to provide is intimately tied to the available cultivars and their characteristics, so cultivar development is an ongoing need.

Importance of Final Consumer Decision Factors

Retailers were asked to rate the factors they believe are important to the final consumer in making his or her purchase decision. Figure 13 gives the results to this question. The image of Hawaii, exotic image, or U.S.-grown do not figure prominently. This should not be too surprising as most final consumers probably care little about these factors or are ignorant of them. It does point out a need, however. If Hawaii marketers want to establish an identity among mainland

consumers, methods to identify the item up to and including the final sale must be established. It will also be necessary to inform and educate the final consumer regarding the existence and uses of Hawaii dendrobium orchids. Hawaii must be able to convince consumers why its dendrobium orchids are special and worth buying.

The items which retailers believe are most important in influencing the consumer's decision are quality, appearance, shelf life, and the florist's recommendation. Obviously, if Hawaii's marketers attempt to establish some "brand" recognition in the eyes of the final consumer, high quality, an attractive appearance, and extended shelf life are musts. Even if Hawaii's marketers are unable to establish a strong level of recognition at the consumer level, efforts to strengthen or maintain Hawaii's standards in these areas are crucial. As has been repeatedly documented, final consumers rely heavily on the florist's recommendation. In order to foster these recommendations, Hawaii's dendrobium orchids must impress the florists. To do so requires good quality, attractive appearance, and a reasonable shelf-life.

The other interesting result is the importance which retailers place on their own recommendation. The importance of the florist's recommendation is supported by other studies. It suggests that Hawaii's marketers should consider methods which make it easier for the florist to sell Hawaii dendrobium orchids. The importance of good service has already been identified. For starters, other activities include design workshops, other suggestions on arrangements and other uses, point of sales materials, and the like. This list is not exhaustive.

Suggestions for Improvements in Marketing: Retailers

Retailers were asked to suggest ways in which Hawaii can improve the marketing of dendrobium orchids (Figure 14). Those items in which at least fifty percent of the respondents indicated a desire for improvement are more colors, longer shelf life, more varieties, greater availability, information on usage, and information on handling. The first four factors are longer-term in nature. The need to continue research on new cultivars and handling methods is obvious. Although there is some printed information on handling and usage, the response for the last two items indicates that these efforts must continue and perhaps be expanded. Container inserts appear to be the most economical method of reaching the audience. However, if dendrobium packs are broken down at the wholesale level, Hawaii's marketers should work with their wholesalers to ensure that this information is being passed on to the retail florists.

Suggestions for Improvements in Marketing: Wholesalers

Wholesalers were also asked for ways to improve marketing. The results to this question are shown in Figure 15. Those items indicated most frequently include more colors, increased supply consistency, longer shelf life, greater availability, information on handling, and more varieties. Again, these indicate a need for cultivar development and increased level of service. Of course,the item "greater availability" may also be a desire for lower prices.

To a large extent retailers and wholesalers are in agreement with respect to their recommendations. The emphasis on colors by both parties is interesting. Fortunately, retailers were queried regarding their preference towards colors. The results of this question are shown in Figure 16. In declining order from most favored color to least favored color they are white, purple, pink, lavender, "art shade," yellow, and green. There is some ambiguity in these selections, but they do provide some guidance for future cultivar development.

Summary

Today we presented preliminary results of surveys of mainland wholesale and retail florists. The purpose was to identify the attitudes, perceptions of strengths and weakness, and usage of Hawaii's dendrobium orchids. Future analyses will identify how these areas of concern vary by firm size (total annual sales) and geographical location and will lead to more detailed recommendations.

Several useful results were obtained from this preliminary analysis. First, especially at the retail level, a significant proportion of respondents were ignorant of the place of origin of their dendrobium orchids. This may account for the relative lack of importance attached to the "image of Hawaii" or "buy American" in flower purchase decisions. If Hawaii orchid growers and marketers wish to more fully differentiate their dendrobium orchids, they must do a better job in establishing their identity throughout the marketing channels.

Hawaii's dendrobium orchids ranked high with respect to quality, appearance, spray length, and shelf life. However, they compared less favorable with other dendrobium orchids with respect to availability, dependability, consistency, and responsiveness. These latter factors may be considered service variables and were often ranked as important when making purchase decisions. Obviously, some of these are related to the biology of the plant and Hawaii's growing conditions. However, better communication and more realistic projections of present and future availability of sprays to buyers may lessen these impacts.

Based on this preliminary analysis, more specific recommendations would include:

1. Service in terms of reliability, consistency of supply, and responsiveness needs to be improved.
2. While Hawaii will always be a relatively high-cost producer, methods to reduce costs, such as new cultural practices or higher yielding varieties, need to be continued.
3. The considerable effort to develop a winter flowering cultivar should be continued, as well as the development of more colors.
4. More efforts need to be made in the area of maintaining Hawaii's dendrobium orchids' identity throughout the entire marketing channel. The use of sleeves with the Hawaii logo is a major step in this direction.

Figure 1
Tropical Flowers Handled By Retailers

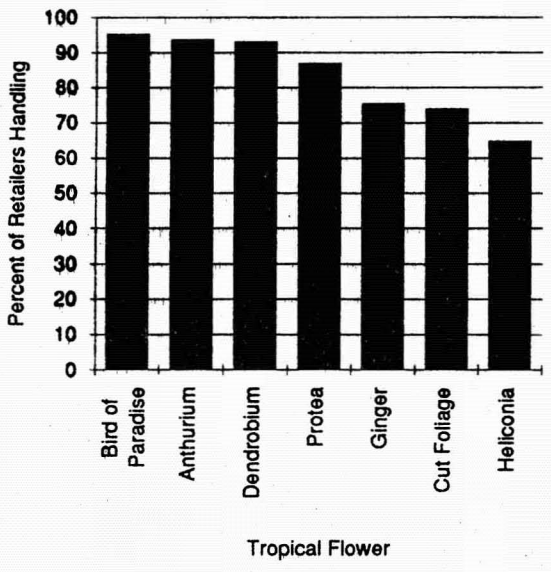


Figure 3
Tropical Flowers Handled By Wholesalers

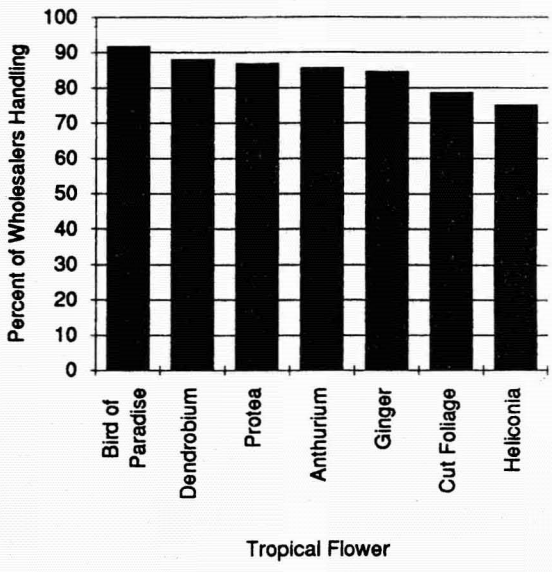


Figure 2
Retailers' Annual Sales of Tropicals
(in $1000's)

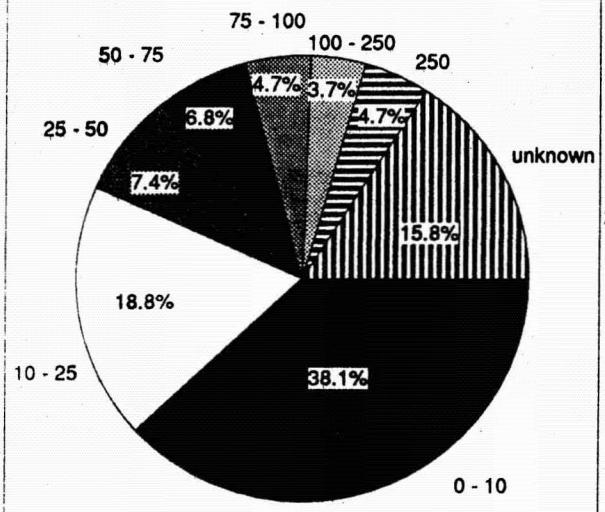


Figure 4
Wholesalers' Annual Sales of Tropicals
(in $1000's)

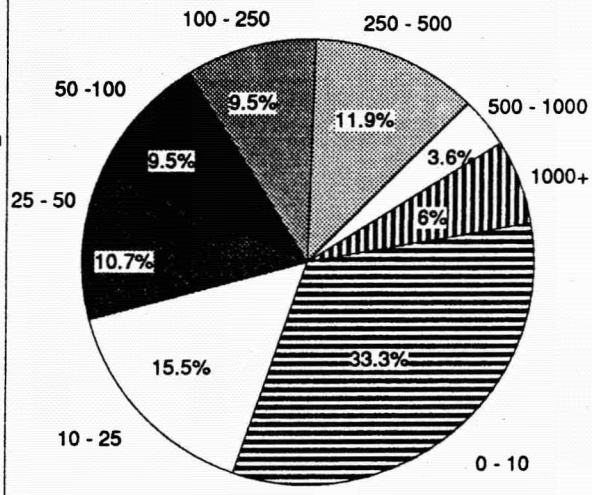


Figure 5
Marketing Activities Conducted By Retail Florists

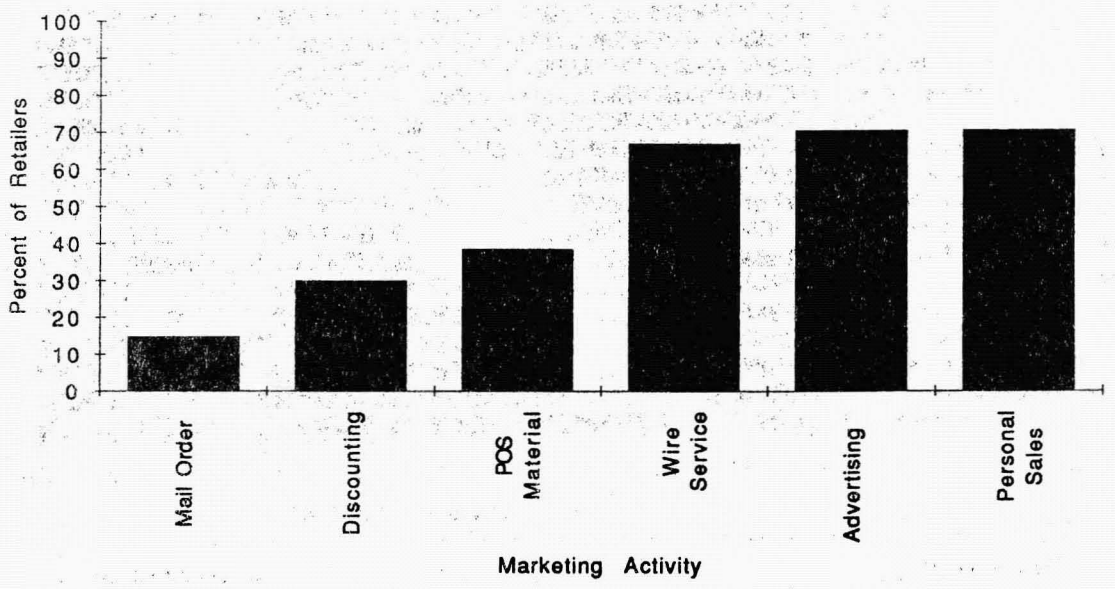


Figure 6
Marketing Activities Conducted by Wholesalers

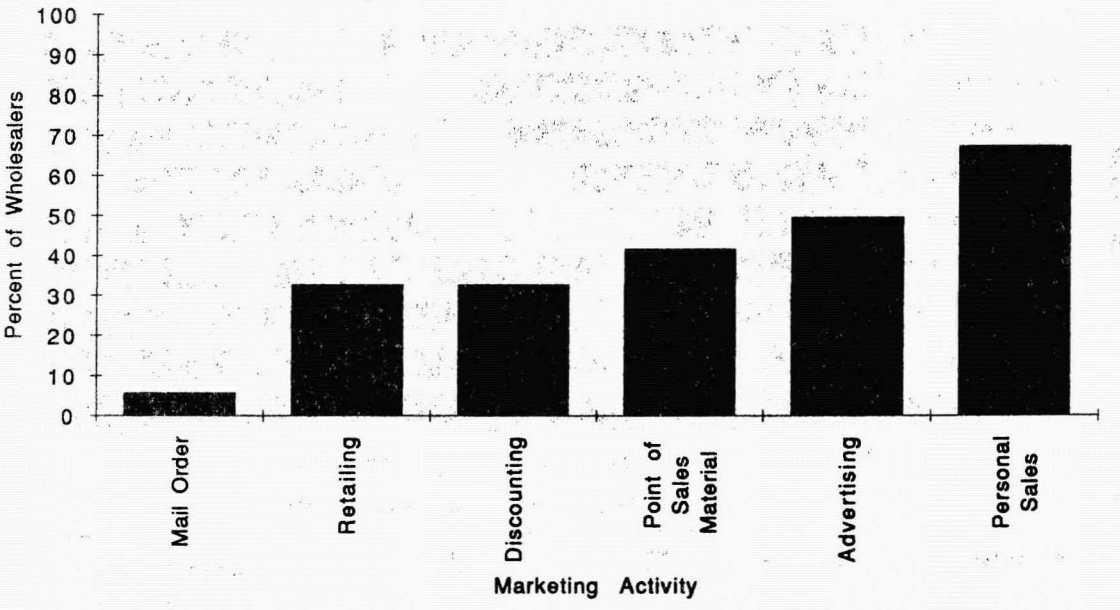


Figure 7
Factors Affecting Retailers' Purchase Decision

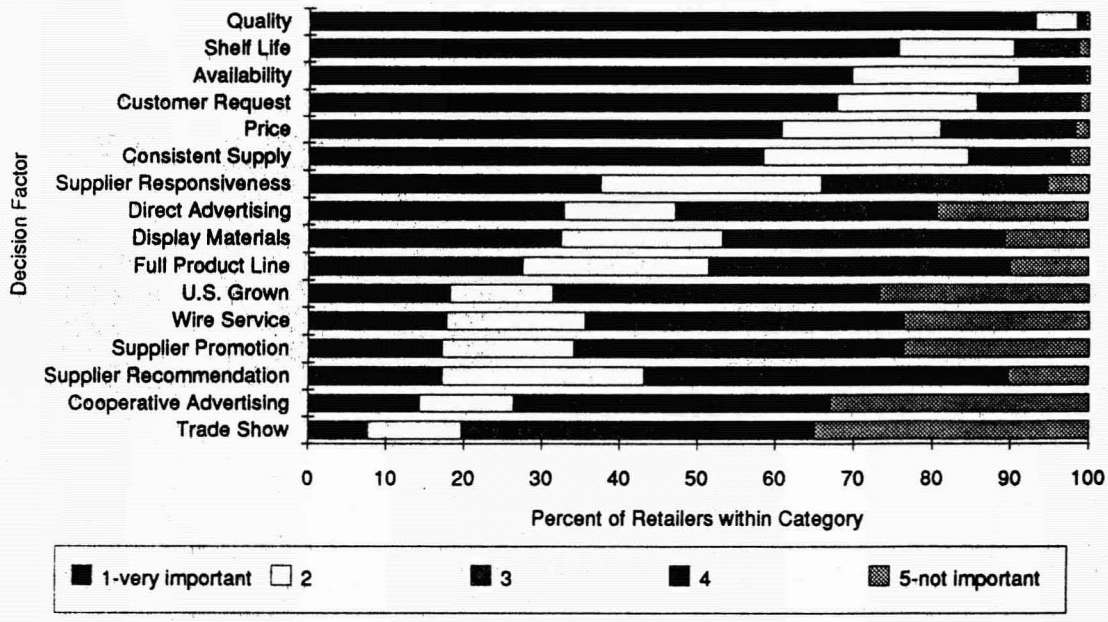


Figure 8
Factors Affecting Wholesalers' Purchase Decision

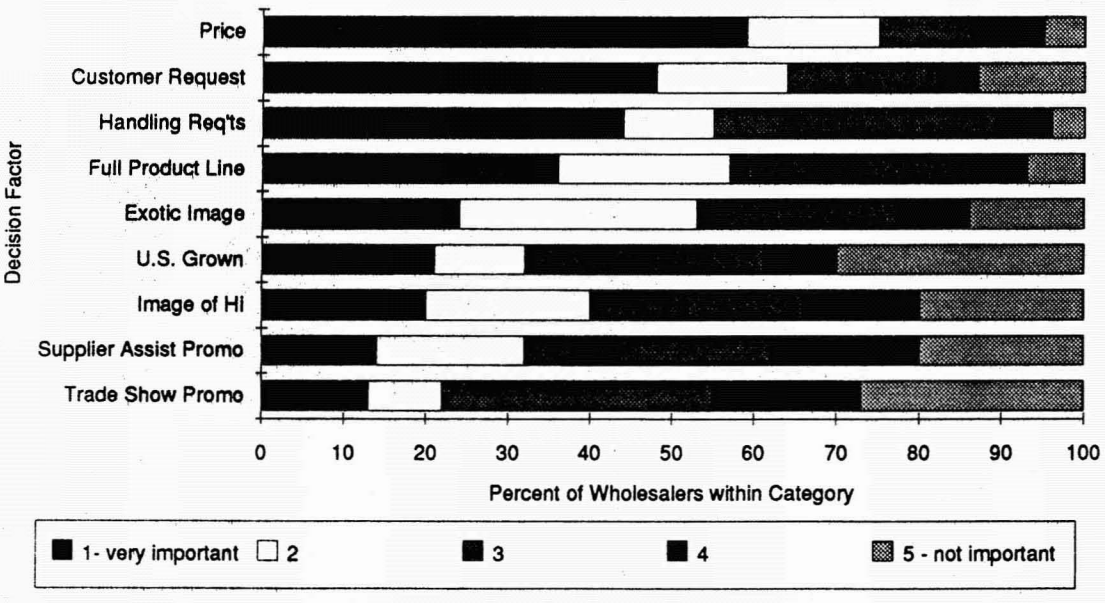


Figure 9
Wholesalers' Source of Dendrobium Orchids

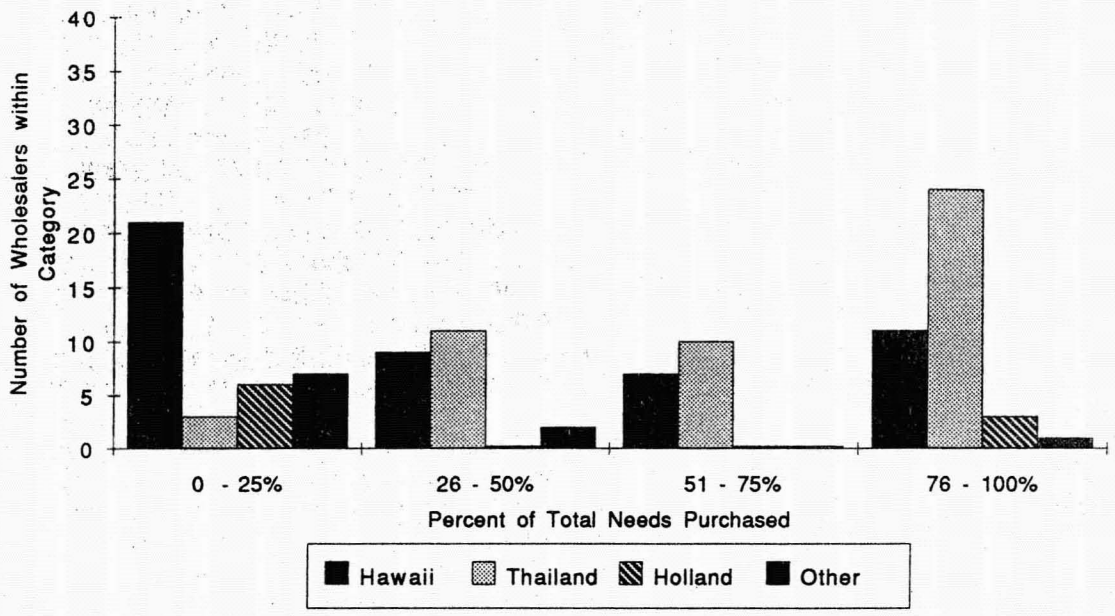


Figure 10
Source of Dendrobium Orchids
As Perceived by Retailers

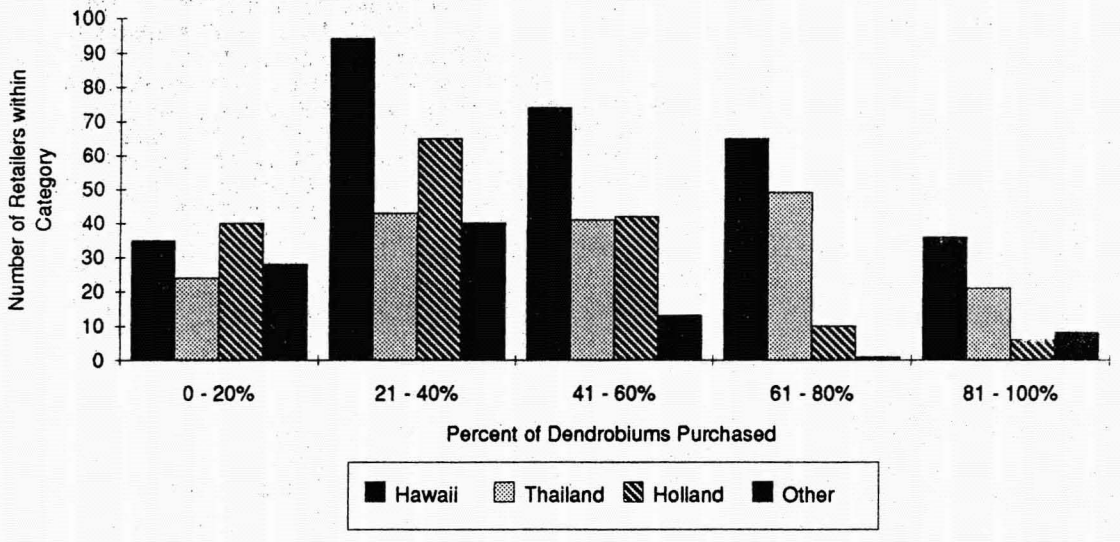


Figure 11
Retailers' Comparison of Hawaii's Dendrobiums
Compared to Other Dendrobiums Hawaii's Are...

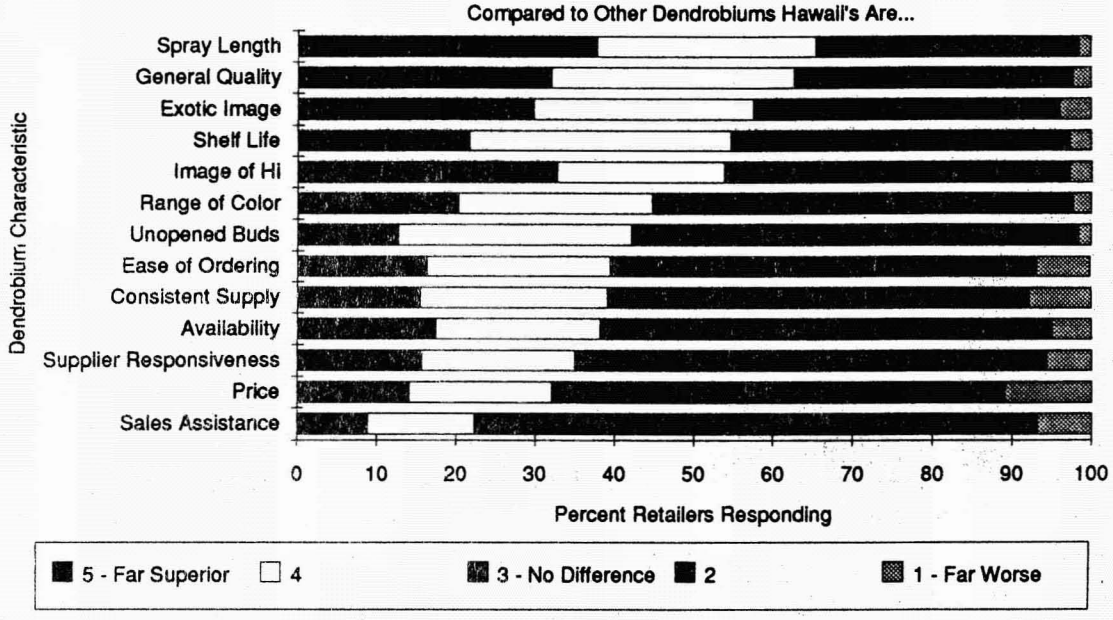


Figure 12
Wholesalers' Comparison of Hawaii's Dendrobiums
Compared to Other Dendrobiums Hawaii's Are...

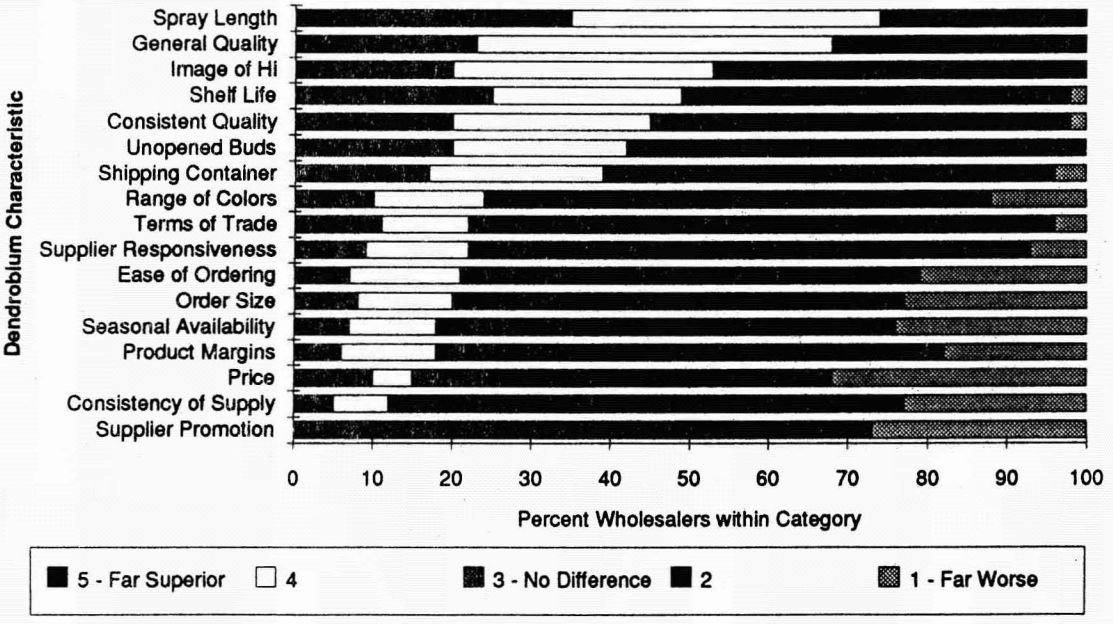


Figure 13
Importance of Final Consumer Decision Factors
As Perceived By Retailers

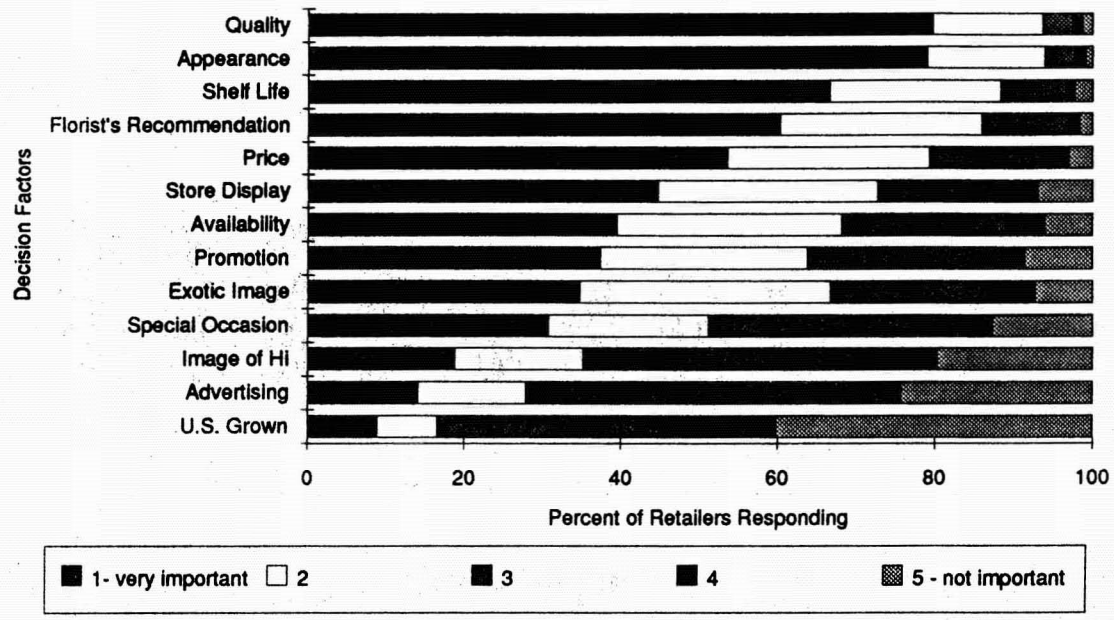


Figure 14
Suggested Improvements in Marketing Dendrobiums
Retailers

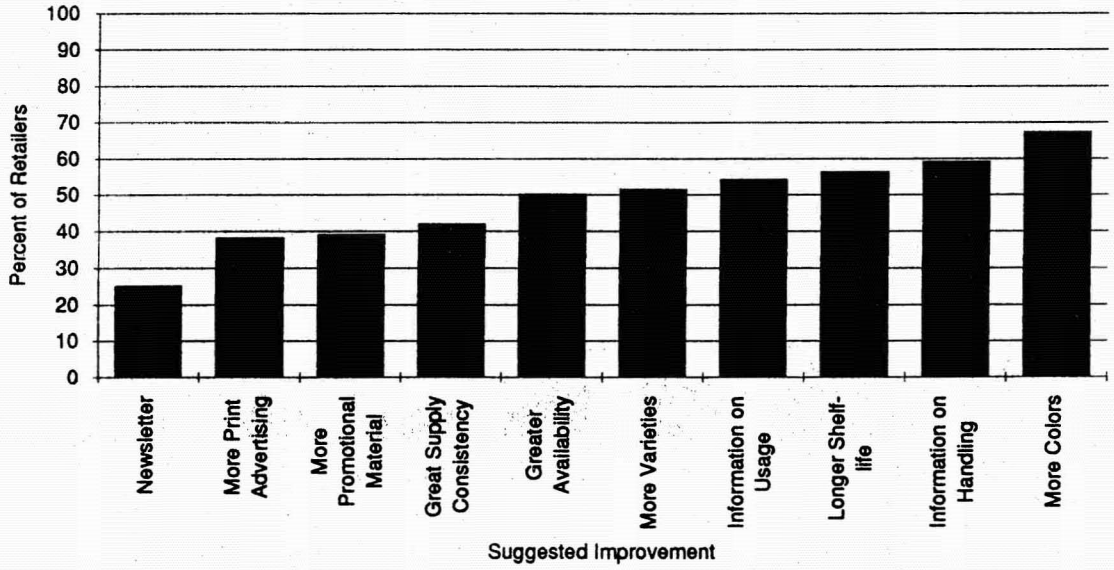


Figure 15
Suggested Improvements in Marketing Dendrobiums
Wholesalers

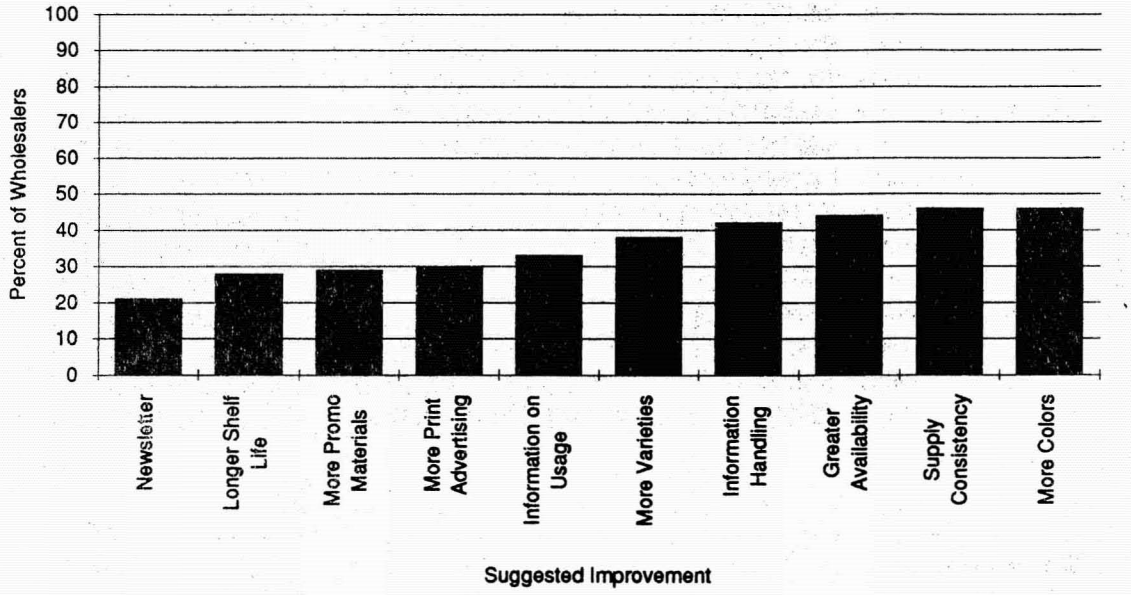
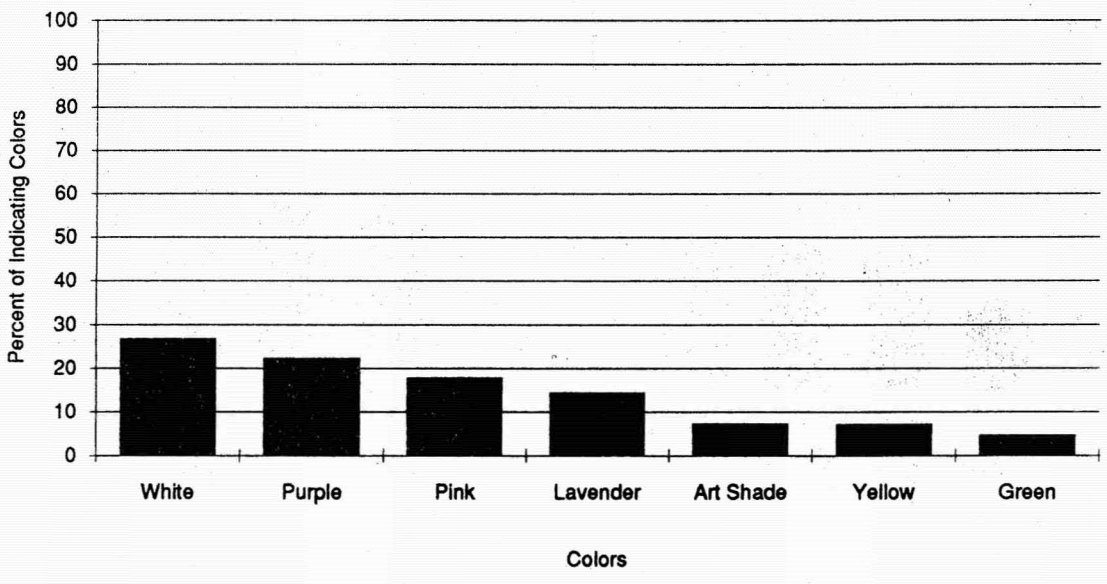


Figure 16
Retailers' Favorite Colors



ECONOMICALLY IMPORTANT DISEASES OF DENDROBIUM

by
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University of Hawaii at Manoa

Phyllosticta, a common fungal pathogen on dendrobium leaves, occurs throughout the state. It is frequently found in the "yellow spot" stage, since this symptom persists for many months. Spots caused by *Phyllosticta* are small (2-4 mm), generally circular, pale green to yellow, and expand very slowly. Fungal spread and development is apparently inhibited by metabolites produced by the actively photosynthesizing leaf. Small, black, irregular leaf spots are also caused by *Phyllosticta*.

Aging leaves, leaves receiving reduced light (e.g., on potted plants in retail stores), or leaves kept in short periods of darkness (e.g., on plants packaged for export), have decreased photosynthetic activity, resulting in lowered resistance and permitting a surge in fungal growth. Yellow spots quickly expand into tan to light brown spots, followed by general yellowing of the entire leaf. Rapid mycelial development darkens the leaf, and thousands of spherical black bodies the size of sand grains are formed. These are fungal fruiting structures, or pycnidia, which produce and then extrude thousands of infectious spores when touched by water. Spores are dispersed by splashing water and germinate by producing a short hypha or fungal thread. The fungus eventually penetrates the leaf surface and feeds on a few dendrobium cells. Thus, water or moisture is needed for conidial (spore) extrusion, dispersal, germination, and fungal penetration into the host.

Economic losses occur because heavy spotting reduces the ability of the plant to produce the expected quantity or quality of flowers. This disease also causes premature loss of foliage, and canes more than two years old may have large numbers of missing leaves.

Serious losses can be incurred by growers who export infected potted plants. Rapid symptom development occurs while potted plants with minor leaf spots are in transit. Reduced lighting, increased humidity, and possible reduction in aeration promote fungal growth in plants that are boxed.

Colletotrichum is another fungal pathogen which causes diseases of economic importance. Serious flower losses occur during the cool, wet winter months, when the fungus causes blossom spots and rots. Infected flowers also rot in transit, further diminishing returns to the growers.

Blossom spots and blights caused by *Colletotrichum* are water-soaked and vary in color (off-white, pink, brown, dark brown, or black) depending on the flower color. Spots expand rapidly in moist weather and may sometimes have concentric rings of

salmon-colored spores. The disease also occurs on spikes and buds as dark lesions. Spikes are generally withered and bent at lesion sites and the apical end of the spikes are commonly found drooping and limp. Infections of floral buds cause bud drop.

Initially, blossom rot was the disease primarily associated with *Colletotrichum*. Inoculations of dendrobium foliage showed that the fungus would cause very limited black spots on mature dendrobium leaves and restricted spots on young tissue, followed by loss of a few infected young leaves. Except for the loss of a few leaves, these plants recovered without further treatment.

Recently, however, fields of defoliated dendrobium have been observed. This rapid defoliation occurred during an unusually long period of rain and high moisture which promoted rapid growth and spread of *Colletotrichum* in fields under saran. Leaf spots were 1-2 inches (2.5 - 5 cm) long and were associated with a broad yellowing of the surrounding tissue. Even after defoliation, fungal inoculum levels remained unfortunately high, due to sheath infections which supported large populations of pathogenic *Colletotrichum*. Young shoots were especially susceptible.

Colletotrichum spores are produced in tiny compact masses and are dispersed readily by splashing or running water, handling of infected tissue, and possibly by insects.

The *Colletotrichum* species pathogenic to orchids differs from the more common *Colletotrichum gloeosporioides* by having narrow spores, by growth which is restricted at higher temperatures (more than 88°F), and by tolerance to the fungicide benomyl, which is excellent for the control of many diseases caused by *C. gloeosporioides*.

A third fungal problem well known in the floricultural industry is blossom rot caused by *Botrytis*. Spots caused by *Botrytis* begin as tiny flecks which rapidly expand into spots and then blights. Entire flowers are rotted in three to five days. Floral rot symptoms are very similar to those caused by *Colletotrichum*. In moist environments, *Botrytis* produces fragile clusters of gray to brown spores, which can be seen on rotted flowers. These spores are blown about the nursery by wind currents and do not require splashing water for dispersal. Germination of the spore and subsequent host penetration by the fungus requires water, however.

Both *Botrytis* and *Colletotrichum* are favored by cool, moist environments. Dry environments greatly discourage establishment of pathogens and disease development.

Root rots caused by *Phytophthora*, *Pythium*, and other fungi extract an unknown economic toll from growers. *Phytophthora* is especially damaging in moist locations or in fields with pockets of poor drainage. *Phytophthora* attacks many types of plants in Hawaii and is common on numerous orchid genera throughout the state.

On dendrobium, *Phytophthora* causes seedling losses, leaf rots, cane rots, flower and spike rots, in addition to root rot. Leaf spots are generally irregular in shape, greenish tan in color, and may look blistered or scalded. As the spots mature or dry, they become dark brown and sunken. Young plants or young tissue succumb rapidly, while the disease progresses more slowly on mature, hardy tissue.

Cane is infected through diseased leaves, sheaths, or roots. Apical tip kill of young shoots resembles shoot rot caused by bacteria. Internally, canes infected with *Phytophthora* tend to be dark brown to black, while bacterial infections are usually greenish yellow to brown. Accurate diagnosis should be made by trained personnel.

Phytophthora sporulates on infected dendrobium tissue, producing spores called sporangia. These specialized spores are able to germinate directly by producing several hyphal threads which infect new host plants. Sporangia also germinate by dividing internally and forming about 20 motile spores (zoospores). These migrate from the sporangia and are able to infect new host tissue. Zoospores of *Phytophthora* require water for their formation, release, migration, and subsequent germination. In dry environments, sporangia desiccate and die. Zoospore release is also hampered by warm temperatures, high salt levels, or other water impurities (chlorine, acidity, etc.).

On another front, research in our laboratory has been attempting to determine whether *Phytophthora palmivora* collected from diseased papaya will infect orchids. Over 45 isolates of *P. palmivora* from papaya, another 40 from cacao and orchids, plus others from palm, ivy, *Vinca*, and macadamia were purified and inoculated onto young cacao, dendrobium, and papaya plants. At present, this study shows that isolates of *P. palmivora* collected from diseased papaya or cacao will rarely infect dendrobium. Unfortunately, *P. palmivora* collected from diseased *Chamaedorea* (parlor palm), *Vinca*, or macadamia contained isolates capable of causing serious disease on dendrobium. In these studies, it was also found that *P. palmivora* collected from diseased cattleya, epidendrum, vanda, and other orchid genera were rarely pathogenic to cacao or papaya, but were all pathogenic to dendrobium.

Bacterial diseases are becoming much more common in the dendrobium industry in Hawaii. Effects of bacterial diseases become evident in the second to fourth years after planting. Severe disease occurs during prolonged rainy periods for growers who have their crops under saran. This disease produces yellow leaves, leaf spots and blights, cane rot, and loss of plants; to date, there has been no effective chemical treatment, and chemical control is clearly <u>not</u> a route which is fruitful for controlling bacterial disease.

Bacterial diseases of dendrobium should be attacked by non-chemical control methods which focus on the following: (1) Exclusion: New fields must be started with disease-free plants. In seedling flasks, dendrobium plants are clean but can become rapidly contaminated in the community pot, thumb pot, or 4" pot stage. To avoid contamination, these plants should be grown in an extremely clean glasshouse using new or disinfected pots, unused media, and tools used for this clean area only. Minor contamination of young plants will lead to major disease problems a few

years later. (2) Eradication: In established fields, plants and plant parts showing symptoms of bacterial rot should be removed and destroyed. Plants with bacterial diseases should not be added to compost piles. Applications of Physan, Consan, or other similar quaternary ammonium products will kill surface bacteria, but the field will remain contaminated by internal plant infections. (3) Moisture control: Invest in solid covered greenhouses to avoid prolonged periods of moisture. Avoid using sites previously contaminated with bacteria or areas which might receive drainage water from contaminated nursery areas or from other nurseries.

Viral diseases also cause economic losses by reducing productivity and by symptom expression on certain cultivars during the cool months, reducing production.

An updated summary of common dendrobium problems and control measures follows.

Summary of common dendrobium diseases in Hawaii. J. Y. Uchida and M. Aragaki

Plant parts and pathogens	Symptoms	Control measures: Sanitation and moisture control, plus:
Flowers		
Botrytis spots,	blights	benomyl (Benlate) triadimefon(Bayleton 25T0) mancozeb (Dithane M45) thiram (Spotrete) vinclozolin (Ornalin)
Colletotrichum	spots, blights, spot rot	triadimefon, mancozeb, thiram
Alternaria, Exserohilum, Bipolaris	flecks	mancozeb, thiram
Phytophthora	spots, blights, spot rot	metalaxyl (Subdue 2E)
Viral	streaks, spots	eradication, isolation
Bacteria	spots, spike rot, wilt, and flower drop	isolation,dry environment, eradication
Leaves		
Phyllosticta	yellow to black spots; blights, defoliation	thiram, mancozeb (*prevention*)
Colletotrichum	black spots, blights, defoliation	mancozeb
Phytophthora	blight; defoliation	metalaxyl
Pseudocercospora	spots, defoliation	mancozeb
Misc.Ascomycetes	spots, leaf drop	mancozeb
Bacteria	spots, blights, yellow leaves, defoliation	eradication, isolation
Viral	streaks	eradication, isolation
Root and cane		
Phytophthora	rot; decline; kill	metalaxyl ethazol (Truban 30W)
Pythium	rot, decline	metalaxyl, ethazol
Bacteria	rancid cane rot, kill	eradication, isolation dry environment

VANDA MISS JOAQUIM ORCHID

by
John Wm. Devereux, Jr.
President, Mauna Loa Orchids, Ltd., and Flowers of Hawaii

Quoting Peter Fithian, who is celebrating his 33rd year as founder and co-director of Greeters of Hawaii, the islands' original greeting service, "Contrary to public reports, the vanda is still alive and well--it is the most beautiful of the lei flowers."

Aloha! I am here because of a suggestion I made to include Hawaii's traditional lei-making orchid, the 'Vanda Miss Joaquim' and its sister the 'Shiminishi', in the conference discussions. I am honored to be a part of this excellent "1st Conference," as I know it is the beginning of bigger and better opportunities for all of us.

One year ago, my wife Norva Lee and I purchased Mauna Loa Orchids, Ltd. and Flowers of Hawaii from the William Krueger family, who started it some 45 years ago. This has given me the opportunity to come home to my roots, as I am a fourth-generation islander, having been born and raised in Honolulu. Having lived on the U.S. mainland since 1959 has allowed me to experience firsthand the use of Hawaii's flowers at the Los Angeles Flower Mart, by florists, by others who love Hawaii, including some of last year's 6.5 million tourists, by many of us "transplanted" Hawaiians, and by others. You can be assured that we flower people of Hawaii are performing a real service to those who want to relive their fond memories of Hawaii or to dream of that future visit, through Hawaii's flowers. You and I furnish these, and they are unique, because they are from magical Hawaii. People love our Aloha Spirit, and what better way to provide it than with our flowers!

Our company is a grower, a purchaser from other growers, and a shipper. We specialize in vanda leis, individual cut flowers, orchid sprays, tropicals, foliage, and potted orchid plants. In addition to being used for lei-making, the vanda is used with drinks, as garnish, and on guest pillows. Our customers are the local hotels, residents, and florists, but a larger part of our business is on the U.S. mainland, including the wholesalers, retailers, and ultimate customers. Our manager is Sonoko Tokusato, who has been with the company from its beginning.

To learn more about the 'Vanda Miss Joaquim' orchid, I spoke with Mr. J. Milton Warne of Jack Lane Nursery in Honolulu. Mr. Warne explained that it is a hybrid orchid that was named after a young woman in Singapore when the flower was discovered in her backyard in the early 1890's. According to Mr. Warne, Dr. Harold Lyon of the Hawaiian Sugar Planters Association in Honolulu and Herbert Shipman of Hilo are both credited with bringing this vanda to Hawaii in 1920. The first effort to grow it commercially was in Honolulu in 1936 by Milton and his brother Robert through their Nuuanu Orchid Gardens Company. They had been growing the vanda plants for wholesale when, in 1935, Robert saw a vanda corsage from Singapore

while in Hong Kong and advised Milton of its beauty, suggesting that they mass-produce the vanda through planting of its cuttings. They were the true pioneers of commercializing the vanda, and in 1941 Robert won 1st Prize in the May Day Lei Contest with a vanda orchid lei. This established the beginning of mass marketing of the vanda. Others soon joined, including Senator W. H. "Doc" Hill of Hilo, who through his company, Flowers of Hawaii, Ltd., the forerunner of our company, was among the first to contract shipments to the U.S. mainland in 1946, when scheduled flights were established. At one time he had 600 growers supplying his company, which had 80 lei makers. The tradition was carried on by Randolph Crossley in Honolulu and the Oda family in Hilo, among others.

Unlike the dendrobium, the vanda is sold as an individual flower and not as a stem or potted plant. Prices of up to $0.25 per blossom were not uncommon in the beginning, but they were soon eroded as vandas were sometimes sold in large boxes of 1,000 flowers for as little as $1.00 per box, or ten flowers for a penny!

Let me give you some more recent comparisons of vandas and dendrobium cut flower wholesale prices and trends:

	Vanda				Dendrobium			
Year	Sales ($)	No. sold (1,000)	Av. price (cents)	No. grwrs.	Sales ($)	No. sold (1,000)	Av. price (cents)	No. grwrs.
1970	332,000				40,000			
1981	815,000	57,100	1.43	31	244,000	8,500	2.87	25
1988	888,000	31,100	2.86	24	536,000	19,800	2.71	40

The latest figures available are for 1988, when sales for all individual blooms and lei flowers totaled $4.6 million, with the vanda accounting for over 19 percent and the dendrobium for almost 12 percent. Thus, the 'Vanda Miss Joaquim' orchid, which accounted for a high of 33.4 percent of such sales totalling $3.55 million in 1982, to a comparative 5.04 percent for the dendrobium, is still the most important orchid lei flower. Additional numerical comparisons are included later in this report.

I would like to comment on last evening's seminar. For those of you considering entering the business or who are new to it, some of our experiences may be of help. While most of our shipments are highly successful, our company has experienced a few of the industry's problems as were alluded to at the meeting. Some examples: (1) We shipped 800 vanda leis to a hotel in Washington, D.C., to help celebrate a fraternity's 75th anniversary. Although the hotel received the shipment in a timely fashion, it failed to notify the fraternity. We had shipped properly and in a "traceable" manner, so the customer and we were compensated, but many were disappointed, as the leis were not used. (2) A restaurant in Los Angeles was using

our leis for their hostesses but complaining that the flowers were staining their clothes. Upon an unexpected visit, I found that the leis were being placed in the freezer instead of the cooler! Now that this has been changed, we have a very satisfied and happy customer. (3) Eighty-eight individual orders arrived at their destinations frozen, which was the fault of the shipper, and we are still negotiating for a refund. Because shippers state they will not be responsible for bad weather, I understand it is advisable to indicate that the product was damaged in order to have the claim honored. (4) An airplane sat for days waiting for a new landing gear at the airport with a number of shipments aboard, including a large order of our leis being sent to Florida. They arrived too late for use, but fortunately the recipient, a retired flower executive, understood the situation, and the carrier also honored our claim. (5) Such understanding is not always the case, however, as evidenced by this example. A shipment of tropicals was held up for a short time by a California inspector and delivered late. The shipper stated to me that release had occurred on Saturday. However, through follow-up I learned that the products had been released early Friday morning. Although we proved the shipper in error, the customer was very unhappy with us for the late delivery and poor condition of the product; it just goes to prove that "you can't win them all." But we can sure try!

We all need to do a better job of marketing our flower industry. I hope that we in the vanda business will form our own group or join with the Orchid Commodity Group to give us more mutual support from the state through its legislature and to experience a stronger position in this wonderful industry. The new steering-committee concept formed last evening is a great plan to help promote all flower products of Hawaii. Through wider and better promotion in a coordinated effort, we should all profit. While working with you toward this goal, my wife and I are truly enjoying this new challenge in a fun, exciting, and emotionally rewarding, and fulfilling people service business. Keep selling "Hawaii-grown" flowers!

In closing, let me thank those responsible for this terrific, well-organized, and well-attended conference. I would also like to give special thanks to Larry Yamamoto of the Hawaii Department of Agriculture for his interest in helping all of us, especially through the FTD Tropical Storm presentations on the mainland. I have attended and have seen Richard Horn, a top designer from FTD, show florists how to use and to care for Hawaii's tropicals. He is also the designer in the Hawaii Department of Agriculture's educational and promotional "Hawaii's Tropical Flowers" video, which is being used by florists everywhere. It is a great sales tool to help florists become more familiar with Hawaii's flowers, thus increasing demand for our products. This is just another way of selling "Hawaii-grown" flowers.

The following statistical information was obtained from the Hawaii Agricultural Statistics Service, years 1974-1989, as supplied by Larry Yamamoto and Bob Morimoto of the Hawaii Department of Agriculture. My special thanks go to Mr. J. Milton Warne and to Mrs. Sonoko Tokusato for their counsel; also to my loving parents for having a large orchid collection and for "forcing" me to work on the orchid plants as I was growing up, "before I could go out to play." As it has turned out, with this new opportunity, I now feel like I am playing rather than working! Aloha.

Vanda Miss Joaquim Sales History

Year	Farms	Total blossoms sold (millions)	Average no. sold/farm (millions)	Average sales per farm	Total wholesales sales value	Average price per vanda (cents)
1974	31	48.0	1.548	$13,870	$ 430,000	0.90
1975	26	42.7	1.642	19,040	495,000	1.16
1976	22	39.0	1.773	21,590	475,000	1.22
1977	28	35.4	1.264	17,890	501,000	1.42
1978	26	43.2	1.662	21,350	555,000	1.29
1979	26	31.6	1.215	16,960	441,000	1.40
1980	35	38.8	1.109	16,370	573,000	1.48
1981	31	57.1	1.842	26,290	815,000	1.43
1982	31	42.5	1.371	38,230	1,185,000	2.79
1983	28	40.6	1.450	43,790	1,226,000	3.02
1984	28	25.0	.893	35,000	980,000	3.92
1985	31	24.0	.774	32,740	1,015,000	4.23
1986	21	26.1	1.243	42,810	899,000	3.44
1987	27	23.3	.863	26,220	708,000	3.04
1988	24	31.1	1.296	37,000	888,000	2.86

Dendrobium Sales History

Year	Farms	Total blossoms sold (millions)	Average no. sold/farm (millions)	Average sales per farm	Total wholesale sales value	Average price per dendrobium (cents)
1977	5	.5	.100	$ 1,000	$ 5,000	1.00
1978	5	.5	.100	1,000	5,000	1.00
1979	9	2.8	.311	8,111	73,000	2.61
1980	21	6.6	.314	8,333	175,000	2.65
1981	25	8.5	.340	9,760	244,000	2.87
1982	37	6.5	.176	4,838	179,000	2.75
1983	42	7.6	.181	5,571	234,000	3.08
1984	37	10.5	.284	8,486	314,000	3.00
1985	44	18.0	.409	10,409	458,000	2.54
1986	42	18.0	.429	11,619	488,000	2.71
1987	42	17.9	.426	11,905	500,000	2.80
1988	40	19.8	.495	13,400	536,000	2.71

Note: Figures not available prior to 1977.

Vanda Miss Joaquim
Individual Blossoms and Lei Flowers

Year	Individual blossoms and lei flowers total sales	Vanda sales	Percentage of total sales
1977	$2,173,500	$ 501,000	23.1
1978	2,471,500	555,000	22.5
1979	2,554,000	441,000	17.3
1980	3,379,000	573,000	17.0
1981	3,536,000	815,000	23.0
1982	3,553,000	1,185,000	33.4
1983	4,145,000	1,226,000	27.1
1984	3,770,000	980,000	26.0
1985	4,423,000	1,015,000	22.9
1986	4,260,000	899,000	21.1
1987	5,498,000	708,000	12.9
1988	4,609,000	888,000	19.3

Dendrobium
Individual Blossoms and Lei Flowers

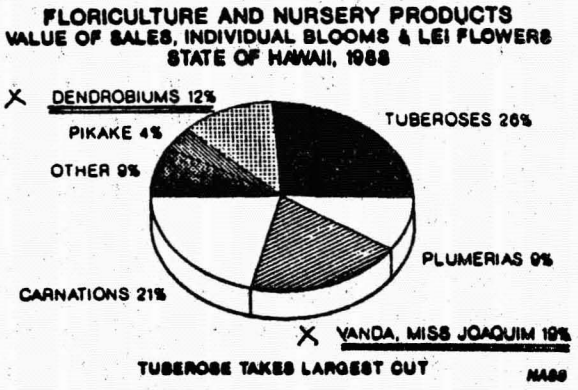
Year	Individual blossoms and lei flowers total sales	Dendrobium sales	Percentage of total sales
1977	$2,173,500	$ 5,000	.23
1978	2,471,500	5,000	.20
1979	2,554,000	73,000	2.86
1980	3,379,000	175,000	5.18
1981	3,536,000	244,000	6.90
1982	3,553,000	179,000	5.04
1983	4.145,000	234,000	5.65
1984	3,770,000	314,000	8.33
1985	4,423,000	458,000	10.35
1986	4,260,000	488,000	11.46
1987	5,498,000	500,000	9.09
1988	4,609,000	536,000	11.63

FLOWERS SOLD FOR INDIVIDUAL OR LEI FLOWER USE

LEI FLOWER SALES DROP 14 PERCENT- TUBEROSE GROWERS HARD HIT BY STORM

Sales of flowers sold for lei or individual blooms grossed $4.6 million for Hawaii's growers during 1988, 14 percent less than 1987. Despite an increase in price for tuberose blossoms, the value of sales, pegged at $1.2 million, was 51 percent lower than the previous year. Tuberose farmers on Oahu began 1988 with a serious setback. A New Year's Eve storm which caused severe flooding to growers in the Waimanalo area resulted in short-term damage to flowers already on plants, as well as the more serious consequence of taking some fields completely out of production for an extended period of time. Growers incurred major costs for clean-up activities and replanting. Production was down 54 percent from the previous year.

Carnation sales, totaling $972,000, remained relatively unchanged from 1987, as price increases helped offset lower production due to disease problems. Most other flowers fared better with increased receipts over the previous year with Miss Joaquim Vandas increasing 25 percent and dendrobiums, pikake, and plumerias registering increases between 5 to 8 percent.



FLOWERS FOR INDIVIDUAL OR LEI FLOWER USE: State of Hawaii, 1986-88

	Type	Farms having sales			Number sold			Value of sales		
		1986	1987	1988	1986	1987	1988	1986	1987	1988
		Number			Million blooms			1,000 dollars		
	Carnations	19	18	17	25.3	26.6	23.3	935	967	972
x	Vanda, Miss Joaquim	21	27	24	26.1	23.3	31.1	899	708	886
	Plumerias	19	19	18	24.4	25.3	25.2	422	413	433
	Tuberoses	6	6	6	38	95.5	43.6	1,075	2,433	1,198
x	Dendrobiums	42	42	40	18	17.9	19.8	488	500	536
	Pikake (000 strands)	18	10	12	182	122.4	128	258	175	189
	Other	NA	NA	NA	NA	NA	NA	183	151	393
	Total							4,260	5,347	4,609

Figure 1. Hawaii Flowers and Nursery Products Annual Summary, Hawaii Agricultural Statistics Service, released August 16, 1989.

PROTEA CULTIVARS AND PRODUCTION TECHNOLOGY IN THE SOUTHERN HEMISPHERE

by
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Protea growers in the Northern Hemisphere have long looked to South Africa, Australia, and New Zealand for a variety of selected cultivars and information on how to manage the crop. With the majority of commercial species of ornamental Proteaceae being native to the Cape Province, and with the quality and quantity of research being conducted there, it is easy to understand why this is considered the center of the protea world. Australia also has some very important genera of the protea family found nowhere else in the world. South African proteas are thought to have been brought back to Australia and New Zealand by soldiers returning from the Boer Wars at the turn of the century, and proteas have been in cultivation there ever since.

In America, three men are generally considered among the pioneers of our protea industry: Howard Asper, Cecil Eschelman, and Ray Miller. Howard, a nurseryman from Escondido, reports that he first tried growing proteas while he was working at the Huntington Botanic Gardens in southern California. Although much of the gardening world knows Asper's beautiful camellia hybrids, he is also credited with bringing in one of the first commercial quantities of protea seed from South Africa and dividing the first seedlings with Cecil Eschelman for planting in the early 1960's. At about the same time, Ray Miller, a landscape designer for the original plantings at Disneyland, "discovered" proteas in South Africa and selected a beachfront in Aptos, just south of Santa Cruz, for his first commercial planting. He felt the climate at Aptos was close to that at the Cape, although he lost plants to a killing frost approximately every five years.

The first commercial proteas in Hawaii were planted as a sideline to other flowers from seed in 1967 by Mr. Shibuya in Kula, after having seen them at the experiment station on Maui. The first full-time protea grower, Gordon Doty, planted a five-acre tract across the street from the station in 1972. This pioneer farm is now owned by Lonnie and Sue Hardesty, Proteas of Hawaii. The second full-time protea grower, Carver Wilson, is still conducting business as Maui Sunbursts.

These first protea farms in Hawaii had no choice but to rely on seedlings from a California nursery, and subsequent increase in acreage in the islands were all planted from seed. Although we were all aware of the variability of plants from seed, we didn't have enough plants to expect to find very many "superior" ones.

On my first trip to study proteas in the southern hemisphere, in 1973, I returned to Hawaii with the strong conviction that for our industry to prosper and to compete on

world markets, we could not afford to rely on seedlings, from California or Hawaii. We must bring in the best varieties we could find, throughout the world, and grow them in Hawaii to select the best for release to our own industry.

Early cultivars from the southern hemisphere, which looked pretty good here, included Leucadendron Hy. 'Safari Sunset' from New Zealand, *Banksia*, *Dryandra* and *Telopea* species from Australia, and *Leucospermum* 'Caroline', 'Firefly', 'Red Sunset', 'Vlam', and 'Veldfire' from South Africa. In the early days, our proteas were pretty much from seed, although 'May Day' and 'Niobe' were available.

Prior to two years ago, everyone was selecting cultivars for their marketing qualities. Longer stems, smaller leaves, clear strong colors, and open-pollinated, or "chance" hybrids that were different. Any disease problems could surely be controlled by the proper chemicals.

Then we began to hear horror stories about the EPA taking effective pesticides off the market, and the realization began to seep in that we could not always depend upon chemical sprays and drenches to help us stay in production!

In the last two to three years everybody is beginning to search for genetic disease resistance. Few cultivars exhibiting superior marketing characteristics have also exhibited any degree of genetic resistance to major diseases. Two outstanding exceptions come to mind. The first is the work being done by Gert Brits (and Sharon von Broembsen, while she was still there), in breeding and selecting for disease resistant rootstock. The second is the work at Proteaflora Nurseries in infecting their leucospermums with *Dreschlera* spores and selecting for tolerance. Leucospermum #52 was released to IPA members as being highly tolerant to *Dreschlera.*

In 1988 and again in 1990 the Hawaii protea industry was given a significant boost over many other production areas by an informal arrangement between the USDA, CTAHR, the Vegetable and Ornamental Plant Research Institute, and SAPPEX, which permitted us to bring back to Hawaii, for the first time, material which displays some tolerance to some of the diseases of proteas. This material will be an invaluable addition to our hybridizing program, under Phil Ito's direction, and in cooperation with VOPRI, we will be evaluating their rootstock tolerant to *Phytophthora cinnamomi* for nematode resistance.

The most intriguing new technology to come out of South Africa, in my opinion, is the concept of developing the strongest possible rootstock, resistant to root rots and whatever else we can find. This material can be planted in the field on a long-term basis, and then as new market cultivars come out of the breeding program, you don't have to pull up your old plants; you merely topwork the new buds into the old rootstock!

Research is currently underway in South Africa to compare the production of flowers from plants that were grafted to their rootstock in the propagating house, as compared to plants budded in the field.

Another subject receiving increasing attention in many parts of the world is developing cultivars specifically for flowering pot plant production. Mr. Brits is particularly interested in the use of growth regulators to induce multiple branching and flowering.

Finally, although not from the southern hemisphere, Israel has been doing a lot of work on producing proteas for cut flowers in artificial medium. Their soil is rather alkaline, and the water quality is poor, to say the least. At the Volcani Institute in Jerusalem, systems are being developed to scoop out growing beds, line them with plastic, and fill them with cinders. The plants are automatically irrigated and fed through a closed system. It occurs to me that there are many parallels here to our future production in the lava fields of Hawaii and East Maui. An international workshop on the subject is scheduled for September of this year, in Israel.

By keeping our communication channels open to the southern hemisphere and other production areas, and with the continued support of the industry and the State, the future bodes well for Hawaii.

MARKETING HAWAIIAN PROTEA TO THE MIDWEST AND EAST COAST

by
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How to enter the marketing and distribution system with wholesalers on the mainland? As a grower and/or shipper, put a customer package together describing your items and availability with supporting brochures and posters.

Survey the market and find the customer that suits your marketing concept. Should it be a shipper, importer, wholesaler, retailer, mass merchandiser, or directly to the consumer, choose one of these customer groups. Don't play the field. You end up spreading yourself too thin and are not able to service any one group sufficiently.

Good wholesalers respect and know each other very well. Once you establish a relationship, your company name will soon be known among the wholesalers.

When you pick a customer group, stay with them in good times and bad. Make sure your are able to supply the wholesaler with the product when he needs it.

Quality plant material produces quality flowers that makes a good grower more successful. This is also true for the success of a wholesaler. We need quality merchandise.

Be different and stand out. This helps your customer to be different and more appealing to their customers.

Communication is the success of many partnerships whether in marriage or business. Consider your customer your partner. Timing a sales call to the wholesaler at a particular time during the day can mean the difference between a sale or a polite "no."

Always ensure that you do your best. There are too many times that by messing up a shipment or by sending the wrong items, you can cause the wholesaler to go buy from your competitors.

Pick the best time to ship your product. If the wholesaler needs to have the shipment by Monday morning, that would mean you would have to pick, pack, and ship on Saturday or Sunday. Do not store product. Don't over estimate your supply and capabilities. Be direct and up front with your customer.

Prices are a very important aspect for both companies to succeed and be profitable. If you agree to a price, stay with it, even though you may hear rumors of higher prices. A bird in the hand is better than two in the bush.

We are in a service industry and that will be the key to your success.

NEW HYBRID *LEUCOSPERMUM* (PROTEACEAE) INTRODUCTIONS

by
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Leucospermum is the most important genus in the *Proteaceae* family for cutflower production in Hawaii. Other production centers include California, Australia, New Zealand, and South Africa. Significant cultivars in Hawaii include *L.* 'Hawaii Gold', *L.* 'Harry Chittick', *L.* 'Coral', and *L.* 'Veldfire'.

This paper introduces five new cultivars that have been developed at the Hawaii Agriculture Experiment Station in Kula, Maui. They are *L.* 'Kathryn', *L.* 'Rachel', *L.* 'Ka Mahina Hawaii' (Hawaii Moon), *L.* 'Ka Pohaka La Hawaii' (Hawaii Sunbeam), and *L.* 'Ka Hoku Hawaii' (Hawaii Star). They are either primary or secondary *Leucospermum* hybrids and each involves the species *L. lineare* in an F_1 or F_2 cross (Figure 1).

Leucospermum lineare was utilized for its early season flowering, long stems, and small slender leaves, while *L. vestitum* and *L. cordifolium* were used for their large flower size. The other two species were selected as parents for their attractive colors; *L. glabrum* for its scarlet ribbons, red styles, and dark green leaves, and *L. conocarpodendron* for its bright yellow flowers. Two or three species contribute 25 or 50 percent of the genome constitution to each hybrid (Table 1).

Leucospermum 'Kathryn' is a selected F_2 seedling using the cross *L. lineare* by *L. cordifolium*, (Hybrid No. 3) as the female parent with pollen from *L. conocarpodendron*. Hybrid No. 3 was used to incorporate flower size, long stems, and good seed set, while *L. conocarpodendron* was used for its bright yellow blossoms. It was selected in 1984 and designated as Hybrid No. 20. *Leucospermum* 'Kathryn' produces bright yellow flowers with radiant golden ribbons and dark yellow styles. Blossoms are large, ranging from 10.1 to 11 cm wide. Flowers come into peak production in March. It has broad, dark green leaves averaging 2 cm wide and 7.4 cm long. Stem length averages 40 cm. Plants are vigorous, highly productive, and have some tolerance to botrytis blight.

Leucospermum 'Rachel' is a selected F_2 seedling using the cross *L. lineare* by *L. vestitum* (Hybrid No. 1) as the female parent with pollen from *L. glabrum*. Hybrid No. 1 was used to incorporate earliness, slender leaves, long stem, and good seed production, while *L. glabrum* was used for its dark green leaves, bright scarlet ribbons, and red styles. It was selected in 1984 and designated as Hybrid No. 29-2.

Leucospermum 'Rachel' produces bright salmon-to-orange blossoms having reddish ribbons and yellow-to-orange styles. The diameter of the flowers ranges from 9.5 to 10.5 cm. Major production occurs in January. It has dark green leaves 1.5 cm wide

and 8.1 cm long. The average stem length is 50 cm. Plants are vigorous, highly productive, and appear to be tolerant to botrytis blight.

Leucospermum 'Ka Mahina Hawaii' is a selected F_2 seeding of Hybrid No. 1 with *L. conocarpodendron*. This selection was made in 1982 and designated as Hybrid No. 14. Plants were propagated by cuttings for testing at various locations in Hawaii in 1984. *Leucospermum* 'Ka Mahina Hawaii' is a very attractive yellow-to-orange sunburst with bright yellow ribbons and salmon-pink styles. Flower size ranges from 10 to 11.3 cm in diameter. Major production occurs in January to February. Stems average 60 cm long with bright green leaves. Length of leaves ranges from 6.5 to 8 cm and width from 1.3 to 1.5 cm. Plants are vigorous, highly productive, and appear to be tolerant to botrytis blight.

Leucospermum 'Ka Hoku Hawaii' is a selected F_2 seedling between *L. cordifolium* and (*L. Lineare* x *L. vestitum*). *Leucospermum lineare* was used to incorporate earliness, long stems, and small, slender leaves, while *L. vestitum* was used because of its good flower size and color. It was selected in 1981 and designated as Hybrid No. 7. Plants were propagated by cuttings for testing at various locations in 1983. *Leucospermum* 'Ka Hoku Hawaii' produces bright red-to-orange blossoms having orange-red ribbons and dark red styles. The diameter of the flower ranges from 9 to 9.6 cm wide. Major production occurs in December. Average stem length is 43 cm. It has green, slender leaves about 1.6 cm wide and 4.8 cm long. Plants are vigorous, highly productive, and appear to be tolerant to botrytis blight.

Leucospermum 'Ka Pohaka La Hawaii' is a hybrid between *L. lineare* and *L. glabrum*. In making this hybrid *L. lineare* was utilized for earliness, long stems, and small, slender leaves while *L. glabrum* was selected for its bright red ribbons and styles. It was selected in 1982 and designated as Hybrid No. 24. Plants were propagated by cuttings for testing at various locations in 1984.

Flowers of *L.* 'Ka Pohaka La Hawaii' are bright red with scarlet ribbons and red styles. The size of blossoms ranges form 9.5 to 10.4 cm diameter. Major production occurs in December to January. Old blossoms are durable and can be used for leis. Stem length averages 49 cm with bright green leaves 9.3 cm long and 1.1 cm wide. Plants are very vigorous, highly productive, and appear to be tolerant to botrytis blight.

Limited quantities of unrooted cuttings of these hybrids are available to Hawaii producers from the Hawaii Protea Cultivar Distribution Foundation, Box 51, Kula, Hawaii 96790. Unrooted and rooted cuttings and small potted plants may be available from protea nurseries in Hawaii.

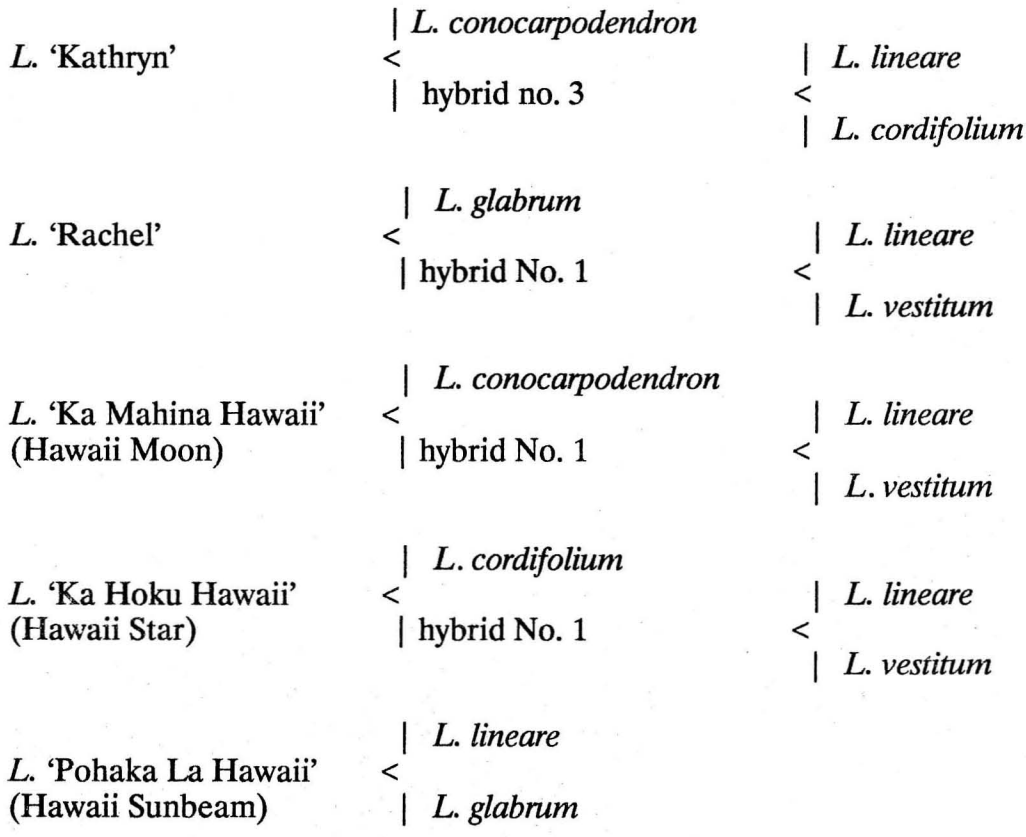

Figure 1. *Leucospermum* **hybrid geneology.**

Table 1. Genome constitution (percentage) of new *Leucospermum* **hybrids.**

	Leucospermum species*				
	lin.	ves.	con.	cor.	gla.
L. 'Kathryn'	25		50	25	
L. 'Rachel'	25	25			50
L. 'Ka Mahina Hawaii' (Hawaii Moon)	25	25	50		
L. 'Ka Hoku Hawaii' (Hawaii Star)	25	25		50	
L. 'Pohaka La Hawaii' (Hawaii Sunbeam)	50				50

* lin. = *lineare*, ves. = *vestitum*, con. = *concarpodendron*, cor. = *cordifolium*, and gla. = *glabrum*.

MANAGING SEASONALITY OF FLOWERING IN HELICONIA

by
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As one of the new cut flower crops, genus *Heliconia* selections are found primarily in upscale flower markets. Rapid plant growth allows producers to be in production less than a year from establishing the plants. Selection of desirable cut flower types remains a problem as there is little published information about their cultural requirements and keeping qualities (Criley 1989). Although species such as *H. psittacorum* are capable of year-round bloom when not limited by cool temperatures (Broschat and Donselman 1983), many of the popular cut flower types have a distinct seasonality for flowering (Criley 1989; Hawaii Dept. of Ag. 1990).

Through study of grower shipping records, the season for peak flower production on Oahu has been established for a number of species and selections. Sampling of elongating pseudostem apices of selected species was conducted during 1987-88 to determine the time of natural flower initiation (Table 1).

Heliconia Wagneriana

Short photoperiods have increased flower production in *H. stricta* 'Dwarf Jamaican' (Criley and Kawabata 1985), and the regulation of flowering in other species by photoperiod was a reasonable hypothesis. Tubbed plants of *H. wagneriana* 'Turbo' were given natural daylengths (ND) (13-1/2 to 11-1/2 hr), 13 weeks of short daylengths (SD) by moving them into a dark chamber (23°C) for 16 hours, or interrupted nights (IN) (25 w/m^2) between 10 pm and 2 am), with the daylength modifications beginning 08/29/89. All pseudostems on the plants at this time were tagged, and leaf numbers were counted.

The first inflorescence appearance (FE) was 12/22/89, with five more within the next 10 days in the SD treatment. The ND plants showed first inflorescences on 02/25/90, in good agreement with field plantings of the same cultivar which came into full bloom in March-April. At this time no flowers were evident on the interrupted-night plants. On May 15, the apices remaining from pseudostems tagged at the start of the experiment were dissected to determine if any reproductive structures had initiated. These apices had aborted in all three treatments. In June-July, two inflorescences appeared on LD plants on pseudostems which had developed after the original stems were tagged. The ND plants were approximately nine weeks later than the SD plants in producing their first inflorescences (Table 2). While a natural initiation time of early December as determined by dissections was indicated (Table 1), it is more likely that the actual stimulus occurred in mid- to late-October, as the reproductive development observed in December had already proceeded to 2-7 cm length. We can estimate, then, a developmental period of 100-

120 days from initiation to emergence of the inflorescence, which correlated well with the mean of 121 days from start of SD to FE in our experiment.

Heliconia chartacea

Despite preliminary indications that *H. chartacea* had a seasonal flowering character, growers have been able to harvest flowers throughout the year. *H. chartacea* shows a broad peak of flowering during April to July in Hawaii, with moderate to scattered flowering during the rest of the year. Dissection of apices of pseudostems which began development during June-July showed reproductive development (3-6 cm) when six leaves had unfurled (Table 1); this was in January-February.

In April 1988, a study was begun to track development from pseudostem emergence to flowering. As shown by low percentages of flowering shoots, some pseudostems aborted the growing point after initiation had occurred (Table 3). From shoot emergence to flowering required an average of 47 weeks for the 137 pseudostems which did flower (Fig. 1). Additionally, there was a seasonal difference with pseudostems which emerged in summer requiring more time to come into bloom than those which emerged in the fall-winter-spring period (Fig. 2). This longer development period was also reflected in a greater number of leaves subtending the inflorescence (Table 3). The data will be subjected to additional analyses to determine if photoperiod, temperature, or light integral influence development, as leaf number and weeks of development showed seasonal differences.

Heliconia angusta

The Christmas heliconia, *H. angusta,* initiates its reproductive structures during July-August in Hawaii and flowers during a six- to 10-week period from November into January. It has been determined (Lekawatana 1986) that four or five leaves must be present before floral initiation can begin. A period of 14-1/2 weeks is required from initiation to anthesis from the four-visible-leaf stage (Table 4). Potted *H. angusta* plants subjected to photoperiods of 9, 10, 11, 12, and 14 hr in a greenhouse produced five, five, five, six, and 10 inflorescences respectively--a suggestion of responsiveness to longer photoperiods, but an average of 75 percent of the apices of flowering-susceptible pseudostems (four or more leaves) aborted, probably as a result of high temperatures under the blackcloth system, and the Chi square statistical determinant was not significant (Table 5). From field sampling of *H. angusta* on Oahu during 1989, it was learned that the inflorescence was already initiated in mid-August, and thus late July may be the time of actual initiation.

Although the range of factors that can influence flowering in heliconia includes photoperiod and temperature, the heavy flowering of wild populations in open clearings versus shaded conditions (Stiles 1979) also suggests an important role for light energy. Manipulation of these factors can extend the period of availability of species with a limited natural flowering season. Better prices can be obtained for early and late-season blooms.

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Table 1. Natural flower initiation period for selected *Heliconia* species in Waimanalo, 1986-1988. The most advanced shoots (leaf number) were dissected for evidence of floral initiation in the month indicated.

Heliconia species	Leaf No. at flowering	Month of flower initiation	Inflorescence length (cm)
H. wagneriana	5 - 6	December	2 - 7
H. bihai 'Kamehameha'	6 - 7	February	2 - 4
H. chartacea	6 - 7	February	3 - 6
*H. rostrata**	7 - 10	March	2 - 4

**H. rostrata* sampled from Paradise Park, Manoa Valley.

Table 2. Effect of photoperiod on the initiation of inflorescences in *Heliconia wagneriana* 'Turbo'.

Photoperiod treatment*	Date of first inflorescence	Mean weeks from start	Mean No. bracts	No. leaves at flowering
Short days	12/23/89	17.3	5.9	5.6
Natural days	02/25/90	27.0	6.0	5.5
Long days	---	---	---	---

*Short day (SD) treatment (8 hr daylight from 07.45 to 15.45) and long day (LD) treatments (25 W/m2 from 22.00 to 02.00) began 8/29/89. SD were discontinued 11/29/89 while LD were continued through March 1990. Natural daylengths ranged from 13.5 to 11.5 hours.

Table 3. Influence of time of shoot emergence on number and percentage flowering and leaf number for flowering stems in *Heliconia chartacea*.

Date tagged	No. shoots	No. fl.	Pct. fl.	No. leaves at anthesis
05 Apr 88	205	25	.07	.8 a*
24 Jun 88	164	25	.08	.0 a
25 Aug 88	1312	92	.36	.8 bc
27 Oct 88	7125	35	.26	.4 cd
29 Dec 88	7033	47	.16	.1 d
27 Feb 89	7531	41	.36	.5 bcd
01 May 89	595	8	.57	.0 b
29 Jun 89	293	10	.46	.7 bc
31 Aug 89	258	32	.06	.1 d
31 Oct 89	338	24	.26	.1 d

*Mean separation in columns by Duncan-Waller's multiple range test at 5% level.

Table 4. Inflorescence production and number of weeks to first anthesis from beginning of photoperiod treatment of *Heliconia angusta* with different initial leaf numbers, averaged over all photoperiod treatments (from Lekawatana 1986).

No. initial leaves/stalk	No. pseudostems	No. inflorescences	Weeks to anthesis
1	24	4	18.0 ± 3.0
2	34	4	20.0 ± 3.0
3	33	8	18.6 ± 2.1
4	63	14	14.5 ± 1.6
5	33	1	14.0 ± 5.9
6	12	0	---

Table 5. Flowering status of *Heliconia angusta* pseudostems under different daylengths. The distribution of pseudostems in each status was not significantly different among treatments (Chi square = 4.858, df = 8, and P = 0.772).

Photoperiod (hr)	Number of pseudostems				Percent flowered
	Total	Flowering	Vegetative	Aborted	
9	41	5	12	24	12.2
10	37	5	7	25	13.5
11	39	5	8	26	12.8
12	37	6	6	25	16.2
14	45	10	11	24	22.2

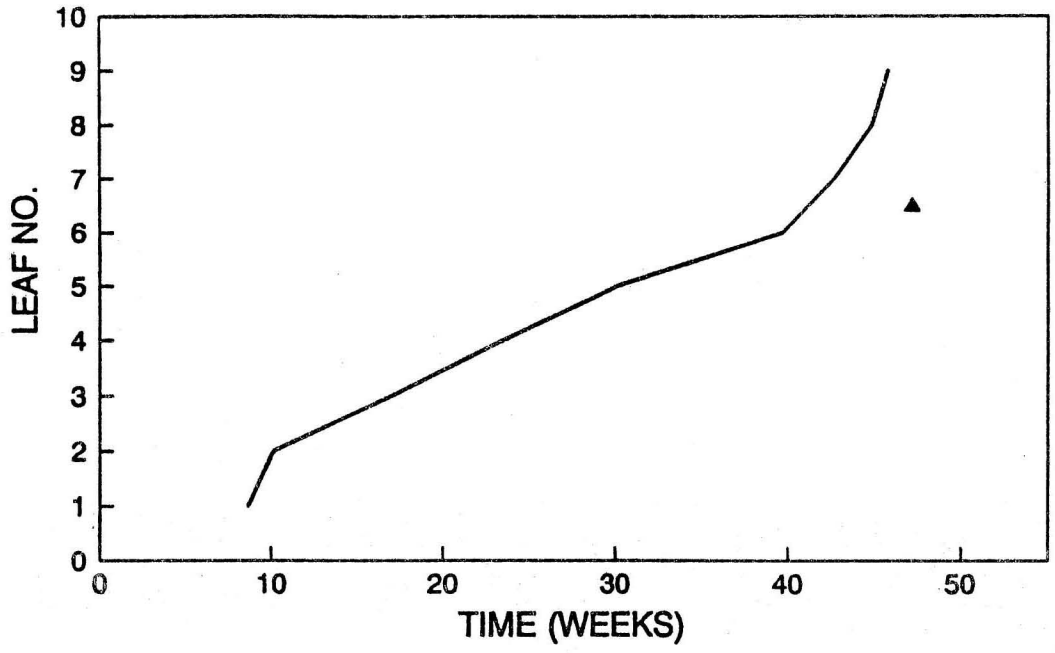

Figure 1. Rate of leaf production (= pseudostem elongation) for shoots of *Heliconia chartacea* tagged at various times of year. Flowering was usually recorded after production of six or seven leaves. The solid triangle represents the overall mean, but the line is extended to include pseudostems with more than the mean number of leaves subtending the inflorescence.

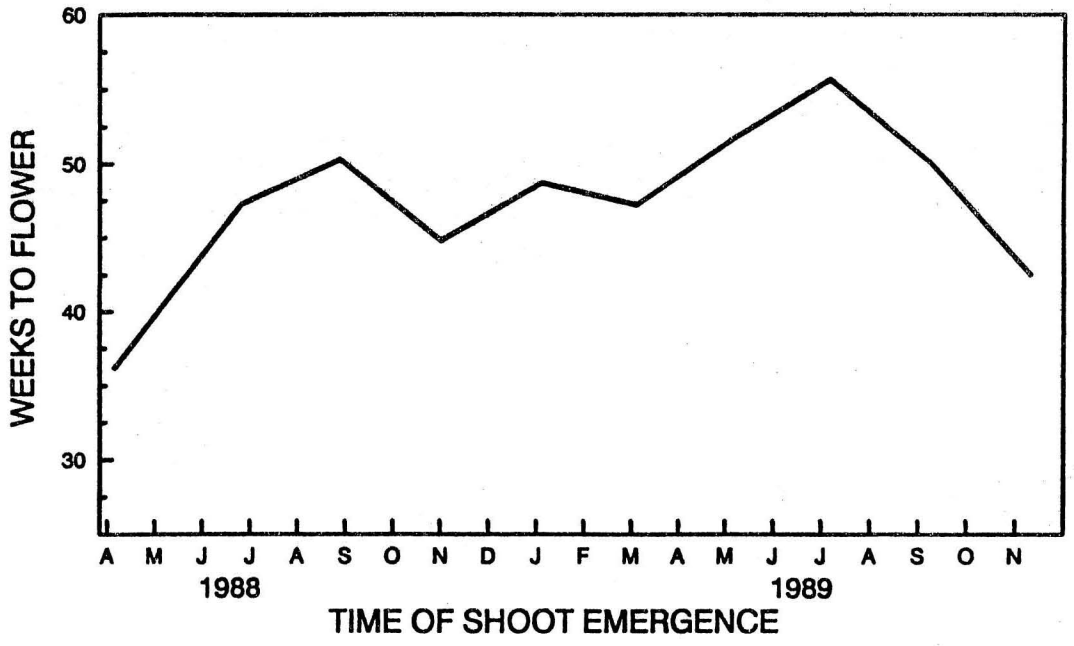

Figure 2. Influence of time of shoot emergence on number of weeks to flower for *Heliconia chartacea*.

LONG-DAY FLOWERING IN HELICONIA ANGUSTA CV. 'HOLIDAY': POSSIBILITY FOR YEAR-ROUND FLOWER PRODUCTION

by
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Introduction

The present paper summarizes previously reported and ongoing studies of photoperiod effects on flowering of *Heliconia angusta* 'Holiday'. This cultivar flowers naturally in Hawaii from November to January with a peak in December, hence, the common names of "Christmas" or "Holiday Heliconia."

First Study

The first study was initiated in June of 1985 at the University of Hawaii at Hilo Agricultural Farm Laboratory. Five rhizomes of *H. angusta* 'Holiday' were planted in beds at a spacing of 4 feet by 4 feet. Data was first taken in September. New shoots were counted and tagged with the month of shoot emergence in the first week of each month. No flowers were produced the first winter (1985), so emerging shoots were continually counted and tagged, monthly, through the spring, summer, and winter of 1986. In the winter of 1986, 41 flowers were produced. For each inflorescence, the month of shoot emergence was obtained from the tag that was attached to the flowering shoot, and this data is presented in Table 1.

During the 18 months from June, 1985, to December, 1986, the five plants produced a total of 157 shoots and 41 flowers (Figure 1). The average was 31.4 shoots and 8.2 flowers per plant. The 41 shoots that flowered in the winter of 1986 were comprised of: one of the 11 shoots that emerged in November, 1985, one of the four shoots that emerged in December, 1985, two of the two in January, 1986, one of the 10 in February, five of the seven in March, seven of the nine in April, five of the eight in May, four of the five in June, and 15 of the 31 in July of 1986.

Of most interest is the fact that none of the 52 shoots that emerged after July (August through December of 1986) flowered in the winter of 1986. This apparently indicated that those shoots that emerged after the first week in July did not receive the stimulus for flower initiation.

The peak in mean monthly temperature occurred in August (78.5°F). However, temperatures in September (77.9°F) were almost the same as that of July (77.8°F). Thus, based on temperature, it did not seem possible that initiation could occur in July, but not in September. The peak in rainfall occurred in April (43.2 inches) with 8.6, 9.1, 11.2, 10.7, 14.4, and 11.5 inches per month for the months of May through October, respectively. Variation in rainfall between July and August, therefore, did not appear to be a factor in flower initiation.

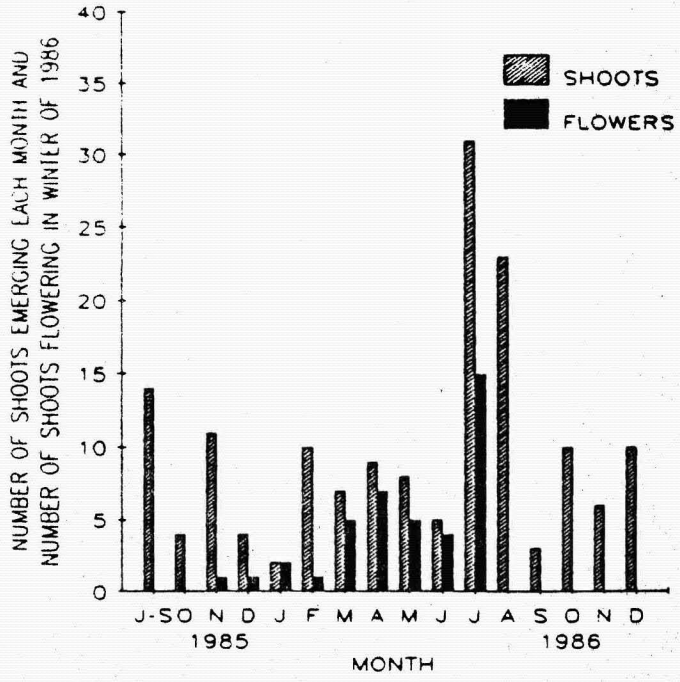

Figure 1. Bar graph showing number of shoots produced each month by five plants (light bars) and the number of these shoots that flowered in the winter of 1986 (dark bars). (From: Sakai, Manarangi, et al., 1990)

Photoperiod, in particular long-day length, thus appeared to be the primary factor in flower initiation. The longest day of the year in Hawaii (June 21) is approximately 13.7 hr, including civil twilight. If three leaves are required on the stem to perceive the daylength flowering stimulus as it is in another heliconia (*Heliconia stricta* cv. Dwarf Jamaican, (Criley and Kawabata 1986), then the critical daylength for flower initiation must probably occur near the end of July. This is because this is when shoots emerging in the first week of July would have three leaves and be able to perceive the daylength flowering stimulus.

The daylength near the end of July is approximately 13.3 hr, including civil twilight. If this is used as the critical daylength required for initiation of flowering, flower initiation in Hawaii would occur during May, June, and July. Development of the inflorescences then apparently takes six months, with flowering in November, December, and January. This long time period for flower development is not uncommon. In *Strelitzia reginae*, the Bird of Paradise, approximately six months are required between emergence of a leaf and emergence of the associated inflorescence (Criley and Kawabata 1984).

Second Study

The second study was initiated in March of 1987. This was a follow-up study to determine if flowering would occur under continuous long days. Twelve 3-gallon containers with approximately seven shoots each were placed in a covered greenhouse under 16 hr daylength by use of 60 watt incandescent bulbs in a 4 X 4 X 4 foot arrangement, similar to the setup used for chrysanthemum lighting. Long days were applied from April 15 through December 15, 1987. An identical 12 containers of plants were placed under natural daylengths which ranged from 13.7 hrs on June 21 to 11.5 hr, including civil twilight, on December 21. New flowering shoots were counted in the second week of each month and the results are shown in Figure 1.

Plants under normal daylength flowered in November, December, and January (Table 1). The twelve pots produced a total of 24 flowers (two flowers/pot). Plants under 16 hr daylength from April 15 to December 15, 1987, flowered from November, 1987, through May, 1988. The twelve pots produced a total of 70 flowers (5.8 flowers/pot).

Table 1. Flower production from twelve pots of *Heliconia angusta* cv. 'Holiday' under normal daylength and twelve pots under 16 hr daylength.

Treatment	Month							
Length	Nov	Dec	Jan	Feb	Mar	Apr	May	Total
Normal Daylength	1	9	14	0	0	0	0	24
16 Hour Daylength (4/15/87-12/15/87)	7	14	18	10	9	11	1	70

(From: Sakai, Nielsen, et al., 1990.)

The use of 16 hr daylength increased production during the normal flowering season (November, December, January) from 20 flowers in the natural daylength pots to 39 flowers in the 16 hr daylength treatment pots. The 16 hr daylength beginning on April 15 also increased production in November from one to seven flowers. Because time of shoot emergence was not monitored, it was not determined if the increase in flower production was due to increased shoot production or an increased percentage of flowering in shoots produced.

The use of 16 hr daylength extended production into the off-season with an additional 31 flowers produced in February, March, April, and May. Again, shoot emergence was not monitored. However, in this case it did appear that the off-season flower production was from increased shoot production. In the first study, shoot emergence was greater in the summer months either due to increased sunlight, warmer temperatures, or increased daylength. It appeared in the second study that increased shoot emergence was also promoted by long days.

Because flowering occurred during the normal flowering season and for four months after with 16 hr daylengths, the second study demonstrated that flower initiation occurred under long days. The second study also demonstrated that flower development could also proceed under continuous long days. This meant that short days were not required for flower development and that 'Holiday' could be forced to flower off-season by providing long days for flower initiation. Flower development could then proceed under either long days or short days.

Climatic differences appeared to affect the rate of flower development. In the second study the time from last long-day (December 15 short days) and last flower (second week in May) was approximately five months. This period was shorter than the estimated six months, from May to November, for natural flower development. Growers also have observed differences in natural flowering time in Hawaii in different years. For example, in 1989 these heliconias began to flower in early November, while in 1987 flowering did not occur until late November. Because daylength does not differ from year to year the differences in flowering time must be related to climatic differences such as rainfall and temperature and their effect on flower development.

If leeway was given for climatic differences, it appeared from the second study that the grower could have *H. angusta* cv. 'Holiday' in continuous flower production from November through May by providing long days from the middle of March through the end of January.

Third Study

In the current study we are providing continuous year-round long days to determine if this will force *Heliconia angusta* cv. 'Holiday' into year-round flower production. The first two flowers were produced in February and we now have about 20 flowers in bloom. Our hope then is to expand the program for winter potted plant production of the 'Holiday' heliconia (Ball, 1987) into a year-round program.

As an additional note, we have also developed some evidence that flower initiation in *Heliconia wagneriana* occurs under short days. In Hawaii the daylength is only short enough in December. This is why the flowering season is very short. Next fall we hope to initiate flowering out of season by use of black cloth to produce short days.

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PHYTOTOXICITY OF MAVRIK AQUAFLOW AND SAFER INSECTICIDAL SOAP WHEN USED AS A DIP ON CUT FLOWERS AND FOLIAGE

by
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Safer Insecticidal Soap combined with Mavrik Aquaflow in a postharvest dip kills aphids, ants, earwigs, and mealybugs on cut flowers and foliage. Tests were conducted to evaluate phytotoxicity of these chemicals on over 20 different floral products. For the tests, the label rates* of the chemicals were doubled so that effects would be readily apparent. Doubling label rates is neither recommended nor legal for insecticide use. After a 15-minute immersion in the insecticidal solution, flowers and foliage were observed for up to three weeks, and their condition was rated on a number scale. Each test included a control batch immersed in plain water. If the treated product aged at the same rate as the control, the treatment was judged safe. If the treated product deteriorated only slightly faster, use with caution was recommended.

If the treated product aged significantly faster than the control, the treatment was judged unsafe. Caution was advised for all anthuriums because mechanical damage and other factors unidentified at this time leave them prone to damage from Safer Soap. The following table displays the results of the tests.

When treating commodities that do not appear on the list, small batch tests should be done and observed for a few days before dipping large quantities and risking damage. Due to the variability of growing, harvesting, and processing conditions in the floral market as well as the limitations of small-scale testing, future results may differ from these.

Precautionary Statement

Use pesticides safely. Follow the pesticide label. Consult with the Cooperative Extension Service or the Hawaii State Department of Agriculture for authorized special local need registration or additional information. The user is responsible for the proper use, application, storage, and disposal of pesticides.

Disclaimer

Reference to a company or product name does not imply approval or recommendation of the product by the College of Tropical Agriculture and Human Resources, Cooperative Extension Service, or the United States Department of Agriculture and does not imply its approval to the exclusion of other products that may be suitable. All materials should be used in accordance with label instructions or manufacturers' directions.

Table 1. Commodities tested for phytotoxicity to Safer/Mavrik dips*.

Safe	Caution	Unsafe
Anthurium foilage	Sago palm	*Dracaena massangeana*
Bamboo orchid foliage	Hala	Dendrobiums
Bird foilage	Anthuriums:	Anthuriums:
Calathea foilage	'Calypso'	'Midori'
Lycopodium	'Marian Seefurth'	'Obake'
Monstera	'Oshiro'	'Okamoto'
Pothos	'Ozaki'	
Ti green/white	'Starlight'	
Ti red		
Ti tops		
Uluhe		
Ginger red		
Ginger 'Jungle King'		
Heliconia 'Andromeda'		

	Safer Soap	Mavrik Aquaflow
*Label rate per 100 gallons of water:	2 gal.	5 fl.oz.
Label rate per gallon of water:	2 1/2 fl. oz.	1/3 tsp.

Acknowledgement

We wish to thank Eric Tanouye and Greenpoint Nursery for providing flowers and foliage for the tests.

THE STATUS OF MOKO AND BUNCHY TOP DISEASES IN HAWAII

by
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I would like to review with you two relatively new diseases to Hawaii, both of which should have some impact on you as growers of tropical cut flowers. These are moko disease, or bacterial wilt of bananas, which sometimes occurs on *Heliconia*, and banana bunchy top virus.

Moko disease is really bacterial wilt of bananas and is caused by the pathogen *Pseudomonas solanacearum*. Several different bacterial wilt diseases caused by this pathogen are known; they are caused by different pathovars or strains. These strains differ only in their ability to infect various host plants. At least four strains have been described and are commonly referred to as the tomato, ginger, banana, and potato strains.

The tomato pathovar (strain), also designated as Race 1 of *P. solanacearum*, was the first strain to be identified; it has a wide host range and attacks many solanaceous plants such as tomato, eggplant, pepper, tobacco, ornamental or diploid banana, and peanuts. It occurs in Hawaii; some of its strains also attack *Strelitzia*, or bird of paradise. In addition to these hosts, many weed hosts are known, which undoubtedly enables the bacterium to survive long periods of time in the soil between commercial crops. As a result, crop rotations are not effective in controlling bacterial wilt of tomato, eggplant, or pepper. The only successful means of control is through the use of resistant varieties.

The second type of bacterial wilt in Hawaii occurs on ginger and is sometimes designated Race 4. It is most important on edible ginger, but it is also found on the ornamental, yellow, white, and Kahili gingers. The disease is controlled by planting clean propagation material in a field that has been fumigated with methyl bromide. Development of resistant gingers has not been required since this bacterial wilt pathovar does not have any known weed hosts.

The next most important pathovar of bacterial wilt occurs on banana. It is known as moko disease, and was named after the region in Honduras where the disease was first identified in commercial plantings of bananas of the United Fruit Co. Some workers also designated this pathovar as Race 2.

Moko disease is confined largely to the Western Hemisphere and has been reported from Costa Rica, Honduras, Guatemala, Panama, Colombia, Venezuela, Peru, Brazil, Surinam, Trinidad, and Grenada. There is one report from India. All commercial or triploid bananas grown for consumption are susceptible. Little resistance in cultivars is known.

Moko is a synonym for bacterial wilt of bananas only. The situation, however, is more complex. Strains of the bacterium that wilt and kill bananas can also cause a wilt on several species of *Heliconia*. Not all strains of the pathogen occurring on *Heliconia*, however, are capable of wilting bananas. In addition, strains of the moko disease pathogen have been reported on 69 different weed hosts in both Costa Rica and Colombia. On some of these weeds, the tomato pathovar was also isolated and identified on *Heliconia*. These findings suggest that *Heliconia* can function as a bridge host between the tomato and banana strains of bacterial wilt.

Disease management of moko disease is quite interesting and worth reviewing since many of the principles would undoubtedly apply to controlling bacterial wilt in *Heliconia*. Control depends on rapid detection and destruction of diseased mats or plants. Detection results from regular inspection of fields on a 2-12 week interval, depending on how important the disease is in the region. To inspect a sucker, it must be slashed and the central core of tissue observed for vascular discoloration. The disease is quite evident on young suckers, as leaves wilt and curl and take on a yellow appearance, and are soon killed. The disease is noted early in the development of suckers, in contrast to Panama wilt, which is caused by the fungal pathogen, *Fusarium oxysporum* f. sp. *cubense*. Panama wilt is usually noted later in the crop cycle, and the vascular discoloration that occurs is largely in the outer leaves comprising the pseudostem. It is clearly different and easily distinguished from bacterial wilt or moko disease of bananas.

Between inspections, machetes are disinfected with a 2% solution of Funginex, Vanodine, Prophyl, or Freshguard. These are bactericidal compounds used in the commercial banana producing areas in Central America.

To destroy the diseased mats, chemical rogueing is usually the method of choice. Several herbicides are used in Central America: 1) a 0.5% solution of 2, 4 D amine is sprayed into the heart of leaf, or 2) a Banvel (6%) and Endothal (60%) solution is injected into the pseudostem, or 3) a 25% solution of Roundup is injected into the pseudostem. It may be necessary to reinject suckers to attain final destruction.

After destruction, the area is fallowed for 6-12 months before being replanted. weeds must be controlled during the fallow period and during the cropping cycle because of the wide host range of this pathovar.

An alternative to rogueing and fallowing is sometimes followed. The infected mat and its adjacent buffer plants are cut down and the area tarped and fumigated with methyl bromide (0.5 kg/m^2). Replanting can occur as soon as a week after fumigation.

The situation for moko disease in Hawaii is far from clear. Probably the easiest way to get a picture of the situation is to review the various rumors concerning moko and try to clarify them. As I best understand the situation, from speaking with many of you, the following is evident.

1. Summer 1988. The Heliconia Society International meeting was held in Florida. Following the meeting, a tour was made to Costa Rica. Several Hawaii members participated and some brought material back to Hawaii.

2. April 1989. A wilted *Heliconia* sample from Maui was received at the Plant Disease Clinic and the bacterial wilt pathogen was identified.

3. The May 1989 issue of HSI journal contained an article concerning moko disease. The article indicated that moko disease was present in Hawaii, according to Wardlaw. Wardlaw had apparently misinterpreted studies by Dr. Minoru Aragaki of UH who reported that the tomato strain was pathogenic on bird of paradise. Wardlaw interpreted that to mean that moko disease was present in Hawaii because of the close affinity of bird of paradise to banana.

4. August 1989. Inquiries were made of the Dept. of Plant Pathology at UH by APHIS, concerning the presence of moko disease in Hawaii.

5. October 1989. A second sample of *Heliconia* from Maui was obtained and isolation confirmed the presence of the bacterial wilt pathogen. Inoculation studies were initiated to determine if banana was susceptible to these isolates.

6. November 1989. Inquiries were made by the Dept. of Primary Industries, Australia, because they had intercepted bacterial wilt from two separate shipments of *Heliconia* from Hawaii. One farm was located on the Big Island and the other on Oahu.

7. December 1989. Wilted *Heliconia* samples were found on Oahu, and the bacterial wilt pathogen was identified.

8. February 1990. Inoculation trials to bananas, *Heliconia*, tomato, and peanuts are inconclusive in identifying isolates from Maui and Oahu as being moko disease, or strains capable of infecting bananas.

9. Arrangements are being made for DNA analysis to determine if *Heliconia* isolates from Hawaii are similar to moko disease isolates.

The other disease I'd like to discuss with you is bunchy top of bananas. It is a virus disease that is new to Hawaii and was identified on the basis of its distinct symptomology on July 7, 1989. It was confirmed on the basis of dsRNA patterns characteristic of infected banana plants and with ELISA test using monoclonal antibodies produced in Taiwan.

Bunchy top is confined to island of Oahu, and was intense in one commercial banana operation, with a few plants discovered in a few other commercial operations. Surprisingly, it was found widely distributed in residential areas on Oahu and concentrated mainly in the Nuuanu and Pauoa Valleys. A program to identify and eradicate the disease is being carried out by the Hawaii State Department of Agriculture. A strict quarantine prohibiting the movement of

banana plants from Oahu to the other islands is in effect. There is no risk with movement of ripe fruit.

An early symptom of the disease is dark green "Morse code" streaking that is first evident on the lower midrib of the leaf and later on the secondary veins of the leaf. Wiping off the waxy buildup on the lower midrib makes the streaks easier to observe. As infection proceeds, streak symptoms become evident on the leaf blade.

Keikis, or suckers, that develop after infection is evident are usually severely stunted, resulting in leaves "bunched" at the top of the stem. Leaves are usually short, stiff, erect, and more narrow than normal. Leaves display marginal yellowing or chlorosis and necrosis or burning. These plants will not produce any fruit.

The virus is spread by the banana aphid. It is not transmitted mechanically via the sap. Disease symptoms appear approximately one month after infection. Since *Heliconia* and flowering ginger are know hosts of the banana aphid, it is possible for the virus "infected" aphids to move from diseased banana mats to heliconia or flowering ginger. Therefore, when shipping these plants between islands, precautions should be taken to make sure they are free of the banana aphid.

Complete control of the aphid vector and proper removal of diseased mats are the most important factors for disease control. Aphids are first controlled to eliminate or reduce their migrations while the diseased mat is being rogued. Currently cleared on an emergency use basis for one year is the insecticide Diazinon. Elimination of mats can be done mechanically or with herbicides such as Tordon or Roundup. If regrowth occurs, the complete two-step control procedure must be repeated.

The disease is found in most of the banana growing regions of the world except the Americas. It is reported from Australia, New Guinea, Bangladesh, Egypt, Zaire, Hong Kong, Malaysia, Philippines, Taiwan, Sri Lanka, North Borneo, Vietnam, areas of the South Pacific (Fiji, Tonga, Samoa, Wallis, Ellice, Guam, and the Commonwealth of the Northern Marianas), and now, Hawaii.

The disease most likely arrived in Hawaii through the illegal entry of banana corms into the state. Banana importations are strictly regulated to minimize the entry of pests of important crops of value in the state. It is interesting that bunchy top was introduced in spite of regulations concerning importing of bananas.

Currently, although the tropical cut flower industry as grown significantly in the last five years, no regulations exist concerning the importations of plants. If we are to reduce to the risk of introducing new diseases such as moko disease or *Cylindrocladium* rot, which has been known only in the last four to five years, some form of quarantine should be required. If the cut tropical industry in Hawaii is to grow , export markets will undoubtedly be important. Keeping the important disease out of Hawaii is the only way to assure that Hawaii's cut flowers are always accessible to those markets.

NEMATODES: HOW THEY AFFECT YOU AND YOUR CROP

by
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Nematodes can be found practically everywhere people cultivate crops. Nematodes are small microscopic eelworms that are quite distinct taxonomically from the true worms. Of the several thousand species of nematodes that live freely in fresh or salt water and the soil, or are found feeding on animals or even man, only several hundred species are considered parasites of higher plants.

The plant parasitic nematodes range in size from 1/100 to 1/8 inch long and generally are cylindrical in shape, with a head and tail. There are males and females to each species, and female species are known to become swollen or greatly enlarged as they mature. The characteristic feature that all plant parasitic nematodes have is a feeding apparatus called a stylet or spear. This stylet is embedded within the head portion and is used for piercing a hole through the surface of a plant cell. Once the cell is punctured, the nematode will feed on the internal plant cell contents.

Plant parasitic nematodes are commonly found in the root zones of plants and are considered as obligate parasites. The nematodes will feed on plant root tissues from the outside (ectoparasitic) or from within the root tissues (endoparasitic). There are a few exceptions to this. Some nematodes are found feeding on above-ground parts of plants such as flower buds and leaves. Due to their very small size, nematodes don't travel great distances on their own. At most they may travel up to a meter per year. Adult female species known to move freely through the soil to feed are called migratory, and those which immobilize themselves in one place, in or on a root, are called sedentary.

The life cycle of plant parasitic nematodes is fairly simple. They have six stages: egg, four larvae or juvenile stages, and adult. Although there are known male and female species, it is not always necessary for males to be present for reproduction to occur. Some females will produce sperm and eggs by themselves. Under ideal soil temperatures, a nematode can complete a life cycle in about 30 days or less. A female nematode can produce between 50 to 500 eggs in its life span.

Recognizing nematode problems is not plain and simple. Plants suffering from nematode damage can express various above-ground symptoms which can be mistakenly diagnosed as a nutritional disorder. Plants usually appear weakened, stunted, chlorotic (yellow), and may have reduction in yields. Many times the plants will not respond to fertilizer applications due to already-damaged root tissues. These symptoms are just clues and should not be relied upon to claim a nematode problem. It is always important to have the soil or roots examined by an expert or

laboratory for confirmation prior to making assumptions about a nematode infestation. On the other hand, below-ground symptoms can be more useful in certain situations. One of the most devastating nematodes is called the root-knot nematode, and it will cause unusual galling or swelling of the root tissues. Other symptoms are stubby roots or necrotic lesions on or within the root tissues. A word of caution: certain legume crops are nitrogen fixing plants and will produce nodules along the root strands that can be easily mistaken for nematode galls.

Once a nematode problem is identified, you must decide what approaches need to be considered, but let's take this one step back. By far, the best approach to nematode control is preventing a nematode problem before it occurs rather than try to treat it after it is established.

Since most nematodes are poor migrators, movement from one location to another is usually through man or nature. This can be by moving infected soil or infected plants, or by flowing water. When establishing newly cleared land, always select only clean healthy material for planting. This will be the most beneficial thing one could do when cropping on a piece of land. Many of the ornamentals used for cut flowers and foliage are propagated vegetatively, and that is an easy way of moving nematodes into a new area. Always buy certified material or make visual checks for any signs of damage on the roots. This may be a painstaking task, but it could save thousands of dollars in the future on nematode treatments for control.

The other control measures that can be considered are crop rotation, fallowing, resistant varieties, and chemical treatments.

Crop rotation. Many organisms, including nematodes, have a preference as to which crops they will feed upon. Thus, if a preferred crop is planted repeatedly for years, then the nematodes will increase over a period of time. By disrupting this cycle with a non-preferred crop, the nematodes will diminish due to the lack of an ideal food source. This is also effective for controlling some other soil-borne pests such as fungi and bacteria.

Fallowing. This method is used when nematode populations have reached alarming numbers. To fallow is to leave a field vacant for a prolonged period, being sure that no vegetation grows in it. As with crop rotation, if there is no food source, the nematodes would eventually die. Fallowing during the summer months is ideal due to the higher soil temperature and the reduction of soil moisture levels, both being equally important. Turning the soil to bring up soil from lower levels is suggested. As with any other animal, nematodes cannot withstand prolonged periods of high temperatures. The drawback of this method is that there is a potential of loss of soil organic matter, increased danger of soil erosion, and loss of production time. In Hawaii, most commercial growers are faced with limited land space, so this may seem to be an infeasible choice; however, one may consider fallowing smaller sections of the total land space. This could be done every summer, selecting different plots within the field.

Resistant varieties. Host plant resistance offers a less costly and more effective means of minimizing losses due to nematode damage. This method only works for those crops where resistance-breeding studies have identified selected varieties. Unfortunately, there has not been any in-depth research on ornamental crops. The majority of the studies were done on vegetable crops. Tolerance is also mentioned here because although some plants may become infected, the infection is mild and plants appear to tolerate mild nematode infections.

Chemical applications. This is one of the last approaches that can be considered if everything else fails. There are two major groups of nematicides used, and they are identified by their mode of action. One group is the fumigants, which are gases or liquids that spread through the soil layers in a gaseous state. The other group is the water-soluble compounds either applied as a liquid or as a granular formulation. Both require the movement of liquid downwards into the root zone where the nematodes are active. There are several barriers one has to consider first before choosing to use a nematicide. They are very toxic, and all of them except one are restricted products carrying the "Danger" signal on their labels. There is no one chemical that will give 100 percent control. Nematicides should be used with caution, and labels should be checked first to see if it is cleared for use on the host to be treated. All workers should be alerted if a nursery bed is treated, and every precaution should be practiced to avoid coming in contact with these toxic products.

If you do suspect a nematode problem in your platings, have the soil or vegetation root piece analyzed by a qualified laboratory to see if there are any plant parasitic nematodes and how severe it may be. The Agricultural Diagnostic Service Center at the University of Hawaii can process nematode samples. Contact your county Extension Agent first to get instructions on how to collect the sample.

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